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The potential for improved food production in Rivers State, Nigeria through effective crop-livestock integration

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The Potential for Improved Food Production in Rivers State, Nigeria Through Effective Crop-Livestock Integration

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Acronyms

CLI Crop Livestock Integration

FAO Food and Agriculture Organization

IFPRI International Food Policy Research Institute

ILCA International Livestock Centre for Africa

LGA Local Government Area

NBS National Bureau of Statistics

SSA Sub- Saharan Africa

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Abstract

Domestic food production in Nigeria is mainly from small scale rural farmers who make up 80% of farmers in the country. However, the rate of food production is not commensurate with the rate of population growth and Nigeria is still recognised as a country with a stagnating food security situation. Rivers State is a food producing state rich in land and water resources and agriculture is the major occupation of its rural dwellers. Its agricultural systems may, however, need to be improved to make it more productive, profitable and sustainable. Crop livestock integration is a major avenue to improving food production in developing countries and improving the lives of rural farmers but little is known about its dynamics in Rivers State. At present crop, livestock and fish production systems are not well integrated and most waste resources produced from these systems are not fully utilised in the food production circle.

This research explored the food production structures in Rivers State using two communities as case studies. Its findings indicate that although farm systems produce resources which could be recycled into the food production system, deliberate integration is still low among local farmers. The major constraints to crop livestock integration and food production in the region include the location of arable farms, poor transportation and market strategies, low producing technologies and low information or knowledge among farmers. The study concludes with recommendations for improving food production through the adoption of suitable crop livestock practices based on the particular trends observed in the study sites.

Chapter 1

INTRODUCTION

1.1 Introduction

This chapter reviews the aims and objectives of undertaking the research. It highlights the agricultural status of Nigeria in general and Rivers State in particular and explores the issues of food production and security. The concept of crop livestock integration is also introduced to give background information on the research interests.

1.2 Aim and Objectives

The aim of the study was to assess the potential for achieving more stable food production in Rivers State, Nigeria by farmers' adoption of best practice crop-livestock integration methods.

The objectives for achieving the aim were

- Firstly, to evaluate the state of food production in Rivers State, Nigeria and identify challenges in the agricultural sector at the farmer level
- Secondly, to characterise farming practices currently being used and the existing level of crop-livestock integration
- Thirdly, to identify the willingness and capacity of farmers to engage with alternative production practices, and develop recommendations on that basis.

1.3 Background of the Study

1.3.1 Nigeria and Agriculture

Nigeria is a West African country of 36 States (Figure 1.1) with a population of 140, 003 542 according to the national census of 2006 compiled by the National Bureau of

Statistics (NBS 2006). This population is the highest in Sub-Saharan Africa. Nigeria also has the second largest economy in Sub-Saharan Africa and contributes 41% to the Gross Domestic Product of the region (World Bank 2008). After the oil boom of the 1970s, agriculture in Nigeria diminished in importance and this, coupled with high population growth, consequently affected food production and food security. The FAO report on food security and agricultural development in Africa released in 2006, grouped Nigeria in the category of countries with "a stagnating food security situation" (Kidane, Maetz and Dardel, 2006:13).

Fig 1.1: Map of Nigeria showing its 36 States (National Bureau of Statistics 2009)

The agricultural industry in Nigeria has been through ups and downs. According to FAO statistics, food production and export was high between the late 1960s and early 1970s after which it declined but has picked up again since 2001 (FAO Statistical Fact Sheet 2006). Nigeria was a major exporter of cash crops like cocoa (*Theobroma cacao),* rubber (*Hevea brasiliensis*), groundnuts (*Arachis hypogea*) and cereals in the 1960s but production declined and export of most crops is now almost non-existent (Kidane, Maetz

and Dardel, 2006). Cereal production has been stagnant since the mid 1990s and Nigeria has been importing these, especially rice (*Oryza sativa*), to supplement local production. Livestock production, though growing steadily, is still below the rate of population growth and meat (especially poultry despite a ban imposed by the Federal Government) and milk are still being imported. However, agriculture remains a major occupation of Nigerians and a key contributor to the nation's Gross Domestic Product. Since 2001, its contribution has been steadily rising from 29.66% to 41.73% in 2006 with an average annual growth rate of 5% (NBS 2006).

A variety of crops and livestock are grown and raised in Nigeria because of the wide range of climate and weather conditions prevalent across different states of the federation. These include cereals, tuber and root crops, vegetables, fruits and tree crops, cattle, goats, sheep, pigs, poultry, rabbits and aquaculture. Statistics from the Nigerian National Bureau of Statistics also indicate that agriculture in recent years, has been improving especially crop and livestock production which has risen by about 40% and 30% respectively from 2001 to 2005 (NBS 2006). However, these increases are mostly due to expansion of cultivated area rather than increases in yield since local agriculture has not been put under pressure to utilise technologies that improve yield (Cleaver and Donovan 1995). Agricultural projects and systems are still mostly traditional and have not been exposed to western modifications, privatized investments and large scale production. Farmers' inputs into agriculture are mainly in the form of hired labour, fertilizers, local hand tools, hooks and nets and renting/hiring of equipment. The use of improved seedlings, fingerlings, insecticides and other technologically advanced inputs is still low (Derefaka 2002, NBS 2006).

More than 70% of agricultural practitioners in Nigeria reside in the rural areas. It has also been observed that the rural areas house more than 60% of Nigeria's poor and the highest levels of poverty were among households with heads engaged in agriculture and forestry. However, it is also suggested that 16.54% of the national poor cope with poverty by engaging in agriculture (NBS 2004, 2006) and, despite the government's programmes aimed at reducing poverty through agriculture, most rural dwellers and indeed farmers, are still poor (Cleaver and Donovan 1995). This implies that though agriculture is a major tool for improving the lives of a large percentage of Nigerians, it is still failing to make

positive impact on most people. This inadequacy is rooted in the failure of past government agricultural programmes and policies (Dickson 2006). Studies to produce more effective policies and schemes by understanding why past programmes failed to improve the lives of farm households are therefore needful because "Nigeria has a great potential to eliminate food imports, become a net food exporter, generate foreign exchange, enhance agricultural production and improve the well being of majority of the poor masses" (Dickson 2006:2).

1.3.2 Rivers State

Rivers State is located along the coastlines of the Niger Delta region, South of Nigeria bounded by Bayelsa state on the East, Anambra and Imo States on the North, Abia and Akwa-Ibom States on the West and the Atlantic Ocean on the South (Figure 1.1). It makes up 3.71% of the Nigerian population with a total population of 5, 185, 400 people comprising of 2, 710, 665 males and 2, 474, 735 females (Appendix 1, NBS 2006b). It has vast resources in land and water, influencing the cultures, traditions and professions of the people.

Rivers State has grown to be one of the industrial centres of Nigeria especially because of its major contribution to the oil and gas sector of the economy. It is home to the major oil producing communities of Nigeria and host to oil and gas companies. Furthermore, the presence of sea ports exposes it to both national and international trade and businesses. Despite these advantages, recent surveys carried out by the National Bureau of Statistics (2006), indicate that about 30% of the Rivers population had difficulty providing food in their households and 67% of households classified themselves as poor.

The capital city, Port Harcourt has experienced a rural-urban drift caused by the migration of young people from their villages in search of "greener pastures". This trend has made Port Harcourt and other urban Local Government Areas in the state such as Obio/Akpor L.G.A., the most populous areas (Appendix 1). Consequently, farming and other agricultural activities are increasingly being abandoned for "more profitable" jobs in the cities.

1.3.3 Rivers State Weather and Geographic Types

Agricultural production is substantially influenced by climatic conditions such as rainfall, relative humidity and sunlight (Dickson 2006). The Nigerian weather is classified into five major types (Oyegun and Ologunorisa 2002:56) as follows.

1. Type A: Typical harmattan weather characterised by dry winds, temperatures between 12^{o}C-35^{o}C, relative humidity of less than 40%.

2. Type B: Dry but humid weather with little rainfall about 25-50mm per month, 18^{o}C- 35^{o}C temperatures, relative humidity between 60%-90%.

3. Type C: Also called Disturbance Lines Weather. Characterized by moderate to high rainfall of 120-200mm per month, temperatures between 18^{o}C-32^{o}C and relative humidity of 65%-95%.

4. Type D: Little dry season, low to moderate rainfall 120-175mm per month, 18^{o}C - 27^{o}C temperature and relative humidity 65-95%.

5. Type E: Monsoon Rain Weather with high rainfall 300-350mm per month, small diurnal range of temperature and high relative humidity above 80%.

Rivers State experiences many weather types at different points in the calendar. Weather type A occurs from late December into early February and weather type B from late February to March and from late October to early December. Weather types C, D, and E occur in alternate stages between April to early October. These latter three weather types make up the rainy season in Rivers State while the former two make up the dry season. Rainfall peaks in July and September with a short 'August break'. Rainfall is usually higher in coastal areas and maximum temperatures lower than in the hinterland (Oyegun and Ologunorisa 2002). This weather pattern predisposes it to agricultural activities throughout the year.

As its name suggests, there are rivers, streams, oceans and other water bodies throughout Rivers State, increasing towards the coasts and shorelines of the Atlantic Ocean. This places it within the humid agro-climatic zones of West Africa. The climate,

coupled with abundance of water is good for crop and forage production and farmlands in this zone are highly productive (McIntire, Bourzat and Pingali 1992). However humid conditions and relatively high temperatures also support the prevalence of livestock pests and diseases like trypanosomiases (Allison-Oguru, Berepubo and Kalio 2002, Kidane, Maetz and Dardel 2006) which constrain animal production (Steinfeld and Maki-Hokkonen 1995).

1.3.4 Rivers State and Food Production

Nigeria is one of the most resource rich countries in Africa with respect to agriculture. In Rivers State, there is arable land, timber, cash crops, food crops, fisheries, forest resources and livestock. Rivers State was a major contributor to the past agricultural exports of the nation in oil palm (*Elaeis guineensis*), cocoa (*Theobroma cacao*), rubber (*Hevea brasiliensis*), and crude oil. Food exports and hence production, declined after the emergence of the oil industry and presently, food is daily being imported from northern Nigeria, to compensate for the low production (Dickson 2006). For instance, yam (*Discorea spp*.) which is produced locally is still being imported and meat especially of poultry and cattle is also imported.

According to the National Bureau of Statistics only 15.94% of the total population of Rivers State, rural and urban, were engaged in agricultural occupations in 2006 (NBS 2006) as most urban dwellers were not engaged in agriculture. However, it is a major occupation of the rural dwellers and contributes largely to the State's economy. Farmers are usually small-holders and tend to grow a wide variety of food crops, tree crops and cash crops together on fragmented lands ranging from between 0.25 to 5ha. Farming on small pieces of land is common and only about 0.2% of the people in Southern Nigeria have farmlands greater than 20ha (Dickson 2006).

Arable farming is undertaken throughout the year given the long growing periods of between 7 to 12 months. There is little or no crop-livestock interaction as soil fertility is usually sustained by traditional practices of shifting cultivation rather than manuring or fertilisation (Allison-Oguru, Berepubo and Kalio 2002, McIntire, Bourzat and Pingali 1992).

Also, with the presence of forest resources, lumbering, hunting of wildlife and gathering of wild fruits also contribute to the economy. Fishing along coastlines and in rivers and creeks, as well as fish farming in ponds are also major agricultural activities (Allison-Oguru, Berepubo and Kalio 2002, Ejituwu 1991, Otto 2000).

Table 1.1 Major food crops and livestock produced in Rivers State besides fisheries. (Please note that this list is not exhaustive)

Common name / Scientific name	Common name / Scientific name
African oil palm *Elaeis guineensis*	Rubber tree *Hevea brasiliensis*
Cocoa *Theobroma cacao*	Mango *Mangifera indica*
Avocado pear *Persea Americana*	Coconut *Cocos nucifera*
African pear *Dacryodes edulis*	Cassava *Manihot esculentus*
Yam *Discorea rotundata*	Plantain *Musa paradisiacal*
Cocoyam *Colocasia esculenta*	Sweet potato *Ipomea batatas*
Maize (corn) *Zea mays*	Sugar cane *Saccharum officinarum*
Groundnut *Arachis hypogeal*	Tomato *Solanum lycopersicum*
Bitter leaf *Vernonia amygdalina*	Fluted pumpkin (ugu) *Telfairia occidentalis*
Okra *Abelmoschus esculentus*	Water leaf *Talinum triangulare*
Chillies (pepper) *Capsicum spp*	Cucumber *Cucumis sativus*
Curry leaf *Murraya koenigii*	Basil (scent leaf) Ocimum basilicum
Banana *Musa sapientum*	Sour sop *Annona muricata*
Water melon *Citrullus lanatus*	Pawpaw *Carica papaya*
Pineapple *Ananas comosus*	Orange *Citrus aurantium*
Grapefruit *Citrus paradise*	Lime *Citrus aurantifolia*
Tangerine *Citrus reticulata*	Egg plant (garden egg) *Solanum melongena*
Melon (egusi) (*Cucumeropsis mannii*)	
Sheep *Ovis aries*	Goat *Capra aegagrus hircus*
Chicken *Gallus gallus domesticus*	Cattle *Bos primigenius*
Pig *Sus Domestica*	Rabbit *Oryctolagus cuniculus*
Honey Bee *Apis mellifera*	

Most crop farmers rear livestock on a subsistence level and often without much investment of time and money. Livestock are usually kept as a means of affluence or as a fallback for when crop production fails. Presently there is little interaction between crops and livestock. Mechanization even in the use of animal traction is absent or found only on

farms and projects sponsored by the government or oil companies. Processing of food products is mainly cassava into garri, followed by fish processing (cleaning and drying) and palm oil milling from oil palm (Allison-Oguru, Berepubo and Kalio 2002, NBS 2006).

1.4 Crop-Livestock Integration and its Introduction into Rivers State Agriculture

Crop livestock integration (CLI) is the incorporation of crop resources into livestock production processes and vice versa. It is fundamentally a system for exchange of resources such as farm residues, processing residues and by-products, dung (manure), power, finance and even food crops (Sumberg 2003). It is a mixed cropping system that actively engages opportunities for waste recycling making optimal use of resources available on and between farms for food production (Schiere 2004).

The onset and extent of CLI is determined by certain factors primarily, population pressure (Fig. 1.2) (McIntire, Bourzat and Pingali 1992). This is because population pressure influences factors such as food demand and access to land which in turn intensify interactions between crop and livestock systems, hitherto isolated (Blackburn 1998). Also farmers may want to utilise cost effective crop-livestock integration practices to generate essential inputs on the farm such as manure and livestock feed when these become more difficult to obtain otherwise (McIntire, Bourzat and Pingali 1992).

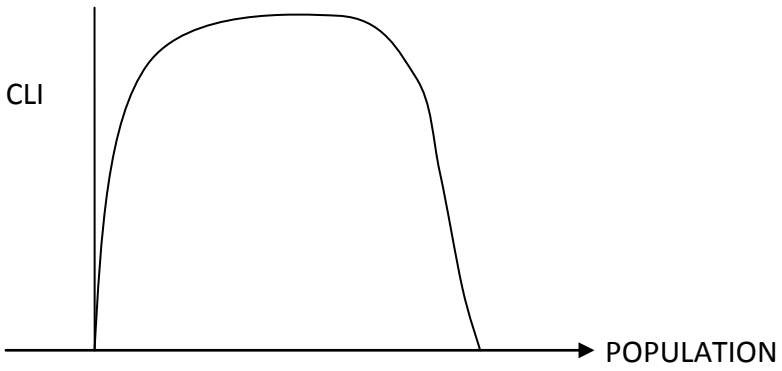

Figure 1.2: Sketch graph showing relationship between population pressure and integration

Population pressure will continue to influence CLI positively (Fig. 1.2) until it reaches a climax where the amount of food produced and the population/market demand reaches equilibrium. At this point, the farmer may likely be successful in both crop and livestock enterprises and may decide to concentrate or specialize on only one aspect which his physical and financial resources may be able to adequately support. Crop-livestock integration could be more easily adopted if the new activity/activities to be incorporated into the food production system do not require excess demands on the pre-existing system in terms of labour and cost (McIntire, Bourzat and Pingali 1992).

Major inputs utilised in a crop-livestock mixed system are crop residues and manure. Most feed for livestock in small scale mixed systems of developing countries come from crop residues after harvest. A study by the International Livestock Centre for Africa (ILCA) in the sub-humid zone of Nigeria, showed that crop residues on farm could provide a relatively higher quality diet for grazing livestock for up to 8 weeks and could reduce the need for external inputs of diet supplements (Powell 1994). Crop-livestock integration aimed at increasing productivity through natural resource management is evolving in Nigeria but its progression needs to be better understood (Manyong, Okike and Williams 2005).

In recent times, the agricultural sector in Nigeria has begun to receive more attention as more awareness is being created by organizations like the Food and Agriculture Organization (FAO) of the United Nations about the state of hunger and food production in Africa. Issues of sustainability and food security have also been on the agenda of world leaders especially after the “Rome declaration” of 1996 (FAO 1998). Nigeria has not been an exception to this and with support from the World Bank and the FAO, the Federal Government has put in place programmes such as the Special Programme for Food Security (SPFS) which aims to improve household food security and hence national food security.

Rivers State has also recently launched the Rivers State Sustainability Development Agency. Supported by the Federal Government, it aims to complement the works of foreign governments and organizations in improving sustainable development in Rivers State. Its aim is to introduce projects to boost aquaculture, cassava farming and micro-

credit schemes among other agro and non-agro projects. Some successes have been recorded in this venture (Government of Rivers State 2008).

However, these and other programmes operating in Rivers State have not addressed the issue of sustainability and food security through crop livestock interactions despite the presence of both crop and livestock agricultural activities in the region. This study aims to address this issue by creating an awareness of CLI practices that help to meet the need for more sustainable and environmentally friendly alternatives to food production.

Pretty, Morison and Hine (2003) in their study of agricultural sustainability as a tool for reducing poverty in developing countries, established that there is considerable increase in food production quality and quantity when sustainable agricultural practices and technologies are adopted by small holder farmers. Research exploring the economic and biophysical dynamics of CLI, and practical technologies has also been generated for developing countries (Sumberg 2003). However, these techniques such as those incorporating livestock into arable cropping or tree plantation systems (Devendra and Li Pun 1993) have not been well adopted by farmers (Manyong, Okike and Williams 2005). The reasons for low adoption of technologies could be limitations caused by technical, socio-economic or institutional factors (Sumberg 2003). This research work will therefore seek to analyse the use of CLI to increase food production in Rivers State, Nigeria, taking into consideration all factors within the food production systems in the region.

1.5 Chapter Summary

Agriculture could be an effective tool for reducing poverty and improving food production in Nigeria and particularly in Rivers State given its geographic and climatic environment. Crop-livestock integration could play an important role in achieving food security in the region but needs to be examined under the context of the Rivers State agricultural systems.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter attempts to give more insight into the state of food security in Sub-Saharan Africa as a region, Nigeria as a country and Rivers State as the state under study. The chapter also reviews the prospects and challenges of Crop-Livestock Integration (CLI) in Rivers State and profiles existing mixed farming systems in other parts of Nigeria.

2.2 Food Security in Nigeria and Sub-Saharan Africa

Food Security, as defined by the World Food Summit, exists when food is always available and accessible, sufficient, safe, nutritious, and satisfactory, supporting a healthy and active life (FAO 1998). By this definition, Sub-Saharan Africa is still far from secure as records show that in 2002, an estimated 200 million people were undernourished. This is 20% higher than the previous decade and hunger is projected to further increase over the next two decades if appropriate steps are not taken (Kidane, Maetz and Dardel 2006).

In Nigeria, food security is a great challenge as there is still a wide gap between food supply and demand (Dickson 2006). However, research by the Food and Agriculture Organization (Kidane, Maetz and Dardel, 2006) indicates an increase in food production in Africa, especially in Nigeria, where there has been a steady growth in production levels. The disparity is because increase in production has been countered by a concurrent increase in population growth leaving Africa the region with the highest percentage of poor and undernourished people in the world (Kidane, Maetz and Dardel, 2006). Global food demand is also projected to increase over the next two decades with about 80% of the demand coming from developing countries in Sub-Saharan Africa (Dar and Twomlow 2007).

Food security is influenced by several inter-related factors significantly, food availability and stability and food access. Food availability in Africa is closely linked to the source of its supply (Kidane, Maetz and Dardel, 2006). In Nigeria, food supply is mainly from

agricultural activities within the country. However, domestic production does not meet the food demand of households and this creates a dependence on commercial importation (Dickson 2006). Cereals, milk, meat, vegetables, sugar and vegetable oil are being imported to supplement local production. This continuous food import, not only causes inflation and the high pricing of agricultural goods, but is also unsustainable and has discouraged the local food production industry (Dickson 2006).

Several studies on agricultural development in developing countries (Cleaver and Donovan 1995, Dar and Twomlow 2007, IFPRI 2004, Kidane, Maetz and Dardel, 2006, Rosegrant *et al*. 2005, Staatz and Dembele 2008) have attributed low domestic production of food to the following factors

- Crop failures due to land fertility issues
- Unfavourable weather and climate (especially since African agriculture is heavily dependent on rain)
- Low technical knowledge of profitable agricultural practices and equipment
- Lack of technology-based agriculture on a significant level
- Unavailability or high cost of inputs
- Poverty and unavailable resources to purchase inputs that could improve production
- Reduction of agricultural work force due to migration to urban areas and poor health or death especially through AIDS.
- Undercapitalization of the agricultural industry
- Refusal of small-holder farmers to invest in their land

Food stability is affected by post harvest losses which could be up to 40% of the harvested produce. This waste is due to inadequacies in harvesting techniques, post-

harvest handling, storage and processing (Dickson 2006). Hence food supply is increased immediately after harvest of the particular product and then diminishes since there are no appropriate storage and/or preservation techniques.

Food access on the other hand is determined by economic, physical, political and socio-cultural factors (Kidane, Maetz and Dardel, 2006). The main economic factor hindering households, especially in rural areas, from accessing available food is the high poverty incidence levels further compounded by rising food costs. Physical barriers to food access include poor road networks and markets and inadequate storage facilities, as SSA is still lagging behind in infrastructural development (Rosegrant *et al.* 2005). These barriers increase transportation and preservation costs, further increasing food costs and reducing the quality of food reaching the consumer. Corruption and poor governance also affects the conception, implementation and sustenance of sustainable agricultural developmental policies and programmes which could improve food supply and access (Rosegrant *et al.* 2005). Socio-cultural influences on access to food abound in most African communities. In a typical Nigerian family, especially in traditional rural households, there is still some level of cultural based gender inequality in apportioning food where males are given more and better quality food while women and children are given smaller portions of food especially of meat or fish.

Food security in Sub-Saharan Africa is also largely influenced by farmers' attitudes. Because farming is a traditional way of life, records are not kept and other proper business methods to ensure profitability are not practised (IFPRI 2004). Expansion is hardly considered even though proper commercialization of so-called subsistence agriculture could lead to poverty reduction (IFPRI 2004). Also agricultural research and food production until recent times enjoyed little or no investment from private, public or private- public partnering investors (IFPRI 2004, Rosegrant *et al*. 2005) and this has further limited the pace of agricultural growth in the region.

The agricultural industry in Africa has done better than other segments of the general economy and it has been established that Sub-Saharan Africa has the capacity and resources to increase its production to meet not just its domestic needs but also for export (Kidane, Maetz and Dardel, 2006, IFPRI 2004). Agricultural development also has

considerable potential in economic growth and poverty eradication in Sub-Saharan Africa (Staatz and Dembele 2008). In the light of this, the international community especially since the World Food Summit in Rome, (1993) has made efforts to reduce hunger and overall food insecurity in Africa. African governments have also pledged to make efforts to meet the food demands of their populace and also work towards achieving the Millennium Development Goals agreed upon by member states of the United Nations in 2001. Subsequently, in 2003, African leaders at the Maputo Summit, (Staatz and Dembele 2008:24) resolved among other items, to

- Revive the entire agricultural sector of their countries
- Encourage more co-operation and assistance from organised bodies and stakeholders
- Adopt sound policies for agricultural and rural development

Some governments have made good progress but with the Millennium Development Goal target of 2015 close at hand, Africa has still not achieved food security (IFPRI 2004).

2.3 Nigeria's Attempts at Improving Food Production

Agriculture was the major and most important contributor to the economy in the 1960s in terms of domestic production, employment and foreign exchange earnings. However, this declined during and after the oil boom of the 1970s and agriculture's contribution to the nation's GDP reduced from 60% in the early 1960s to 48% in the 1970s and to 22% in the 1980s. The decline was also due to inept economic policies and relative neglect of the agricultural sector by the government and public (NBS 2004).

Nigerian agriculture consists of diverse tree and food crops, livestock, forestry and fisheries (Allison-Oguru, Berepubo and Kalio 2002). Despite the agrarian nature of Nigeria, food supply is still below population size and poverty still abounds, particularly in rural areas where two-thirds of the population resides (NBS 2006). Farm holdings are largely on a small holder basis (Dickson 2006, Nworgu 2006) as shown in Table 2.1, and

these form the back bone of the country's agriculture. The table compiled by Nworgu shows that over 80% of farm holdings in Nigeria, are run by small-holder farmers cultivating small pieces of land usually less than 6 hectares. Large farmers only make up 5% of farm holdings in Nigeria.

Table 2.1: Categories of Farm Holdings in Nigeria (Nworgu 2006:25)

Category of Holding	Hectares of land	Percentage of the total holdings
Small-holders	0.10-5.99	81.0
Medium holders	6.0-9.99	14.0
Large-holders	10 and >	5.0

Agricultural research in Nigeria began with the British in the late eighteenth century and has experienced steady growth since the creation of departments of agriculture and research institutes in the early 1960s (Nworgu 2006, Ojoko 2000,). At present there are over 20 Agricultural Research Institutes operating under the National Agricultural Research Systems (NARS). This body also incorporates national universities of agriculture, faculties of agriculture in Nigerian universities, agricultural development projects (ADPs) and some agriculture oriented organisations in the private sector. The National Agricultural Research Institutes (NARI) have four major areas of focus: arable cropping, livestock production, fisheries and forestry.

Past governments had made attempts at solving Nigeria's food security challenges by investing heavily in agricultural and rural development programmes such as those below

- Young Farmers Club (1957-60)
- Agricultural Development Programme (1975)
- Directorate of Food, Roads and Rural Infrastructure (1986)
- National Agricultural Research Programmes (1992)
- National Special Programme for Food Security (1998)

- Agricultural and Rural Transformation Programme (2000)

Despite these efforts, agriculture in Nigeria still shows slow growth. The failure of some of these programmes has been blamed on a number of factors most especially, the government. Corruption, bribery and lack of accountability of public workers and heads of agricultural ministries at federal, state and local government levels has always affected the implementation of projects and programmes to meet the target beneficiaries. Even after implementation, political instability, inadequate funding, and inadequate checks and balances and lack of political will to sustain projects all act against their continuity (Nworgu 2006). The poor performance of agriculture is gradually leading to a food and feed crisis and exacerbating poverty.

The reasons for the failures of agriculture in Nigeria has been summarised by Nworgu (2006:79) to include

- The inadequate supply, poor distribution and poor quality and high cost of farm inputs tools and machinery.
- Financial constraints and high poverty incidence among farmers.
- Lack of infrastructures and social amenities especially in rural communities.
- Illiteracy and lack of technical knowledge and understanding on the part of local farmers.
- Prevalent pests and diseases.
- Unfavourable land tenure systems which are a major barrier to mechanisation.
- Natural hazards and inherent unpredictable weather and soil fertility challenges.
- Lack of appropriate extension services.
- Inconsistent and poor implementation of governments' agricultural policies and programmes.

- Low productivity of indigenous farm animals and crops due to genetics, environmental stress, feed shortage, diseases and poor management.
- Poor pricing and low market incentives which is especially unfavourable to small scale farmers.
- Poor funding of research.
- Increasing rate of deforestation.
- Poor development of aquaculture.

In most cases, the crop sector has done better than animal agriculture and livestock projects do not usually yield impressive results. As a result, there has been relatively low production of meat and other livestock products from farming systems in Nigeria. There is still great need for progress in all sectors of the Nigerian agricultural industry in order to adequately meet both present and future needs. As Nworgu (2006:13) aptly put it "The task ahead of Nigerian agriculture is multifarious and challenging and success will only be achieved through re-orientation, commitment, dedication, sacrifice, honesty, accountability, adequate funding, motivation and cooperation of every Nigerian in particular and the international community in general".

2.4 Food Production and Access in Rivers State

Food production in Rivers State is largely dependent on small-holder systems usually comprising of a farmer (usually head of the household) and members of his/her family in most cases, incorporating the extended family. The household is the major input into the farm providing the basic needs of labour, capital and management. The intensity at which members of the farm family provide these services is in turn influenced by the characteristics of the household itself such as the family composition of gender and age range, social status and economic needs (USAID 2004).

Agriculture in Rivers State is labour-intensive and crude farm tools such as machetes and hoes are the main implements used (USAID 2004). Cropping is more popular than animal

production. This could be because in general, crops feed more people per unit area in terms of calories and protein as portrayed in the table prepared by Spedding (1979) (Table 2.2). Crop farming is usually separated from animal husbandry and interaction is low usually restricted to occasional feeding of crop residues after harvest or applying of animal dung as manure on the crop field. While crop farming is done on a relatively large scale, livestock are usually raised domestically.

Table 2.2: Approximate number of people fed per hectare of land (Schiere, Ibrahim and Van Keulen, 2002:1)

	Protein	Energy
Crops		
Maize (*Zea mays*)	5.2	10.4
Wheat (*Triticum aestivum*)	6.3	8.4
Rice (*Oryza sativa*)	7.0	14.0
Potatoes (*Solanum tuberosum*)	9.5	16.5
Livestock		
Chicken meat	2.5	1.0
Lamb meat	1.0	1.0
Beef	1.0	1.0
Pork	1.4	2.0
Milk	3.0	2.5

In the hinterland of Rivers State, land is abundant and shortage or infertility is sometimes overcome by migration or expansion into forest areas or preserved land. High External Input Agriculture characterised by Schiere, Ibrahim and Van Keulen (2002) as a system largely dependent and running on external inputs, is not common in the State as it is very capital intensive and requires technical knowledge and skill.

2.4.1 Crop Production

Cropping systems practised in Rivers State vary from farmer to farmer and are dependent on the size of farmland available to the farm family. Sole cropping usually undertaken by

large-holders entails planting only one crop on the farm mainly cash crops like oil palm (*Elaeis guineensis*), rubber (*Hevea brasiliensis*) and cocoa (*Theobroma cacao*) for export or local sale (Otto 2000). More popular cropping systems are inter-cropping, mixed cropping and double cropping. In inter-cropping, two or more crops are planted together either in pure stands or in alternate rows (USAID 2004). While in mixed cropping, only one major crop is planted on the farm usually cassava (*Manihot esculentus*) or yam (*Discorea rotundata*) and one or more other supplementary crops planted in-between. Double cropping, on the other hand, entails planting a crop at the beginning of the planting season, and later in the planting season, the same crop is replanted or a second crop is introduced (Allison-Oguru, Berepubo and Kalio. 2002).

The bush fallow farming system is common in the State more so in the uplands. It involves clearing primary or secondary vegetation to cultivate the farmland for 1-3 years and then leaving the site to regenerate for another 4-10 years (Allison-Oguru, Berepubo and Kalio 2002, Otto 2000). Fallow is the main means of maintaining fertility and weed control because it makes less demand on labour compared to manuring (Powell 1994, Sumberg 2003). There is generally, low demand for crop-livestock integration because there is little demand for animal power or manure by the local farmers (McIntire, Bourzat and Pingali 1992).

The market systems are usually traditionally based and road networks, particularly those linking the riverine communities, are poorly constructed. Other challenges faced in crop production in Rivers State are in the cost and availability of inputs such as fertilisers, labour shortages and costs during the planting season, capital for expansion and inability to expand due to land fragmentation (NBS 2006). Furthermore, the necessary extension services are scarce especially in the closed-in riverine communities where linking roads are absent (Ojoko 2000).

2.4.2 The Livestock sector

Animal production is usually undertaken to supplement crop farming and on a subsistence level. Livestock are sometimes kept only as a mark of wealth, as surety for

investments or loans and also for traditional, religious and social reasons (FAO 1983, Powell, Pearson and Hiernaux 2004, Schiere, Ibrahim and Van Keulen 2002). Animal numbers in Rivers State vary widely according to location and crop production in the area. Poultry numbers in the state exceed that of other livestock ranging from 10-20 birds per km^2 in the coasts to 100-200 per km^2 in the uplands. Poultry kept in Rivers State include chickens (*Gallus gallus domesticus*), ducks (*Cairina moschata*), turkeys (*Meleagris gallopavo*) and pigeons (*Columba domestica*). Small ruminants i.e. goats (*Capra aegagrus hircus*) and sheep (*Ovis aries*) are the second popular livestock in the state ranging from between 5-20 per km^2 in coastal areas to 50-100 per km^2 in the uplands. Pig (*Sus Domestica*) numbers range from 5-50 per km^2 and are increasing rapidly (Bourn *et al.* 1994). Livestock numbers tend to increase in areas of crop cultivation and high density of rural settlement (Bourn and Wint 1994).

A challenge common to developing nations is that of feeding livestock mainly due to low production of conventional feed materials. In Rivers State, as is in most of the humid tropics, livestock are usually raised in extensive systems and are encouraged to graze on natural pasture, forest areas, roadsides, fallow lands or crop residues and other by-products (Schiere, Ibrahim and Van Keulen 2002). These are sometimes either intensely competed for by humans or of low nutritional value. The improvement of animal feed in these areas must harness better use of traditional feed resources (Timon 1993). There is little or no market for crop residues or exchange and farmers usually source these informally (McIntire, Bourzat and Pingali 1992).

An inherent constraint to the animal industry in Rivers State is the humid climatic conditions which expose livestock to adverse weather and also aid the proliferation of animal pests and diseases. This is further compounded by the lack of, or unawareness of farmers to vaccines and medicines for prevention and/or treatment of diseases (Bourn and Wint 1994). Sometimes farmers are simply unwilling to take the needed steps to prevent or cure diseases using veterinary medicine.

Native breeds of poultry, sheep and goat are known to be low yielding (Allison-Oguru, Berepubo and Kalio 2002) although thorough research has not been carried out as to why this is. It has been blamed on weather conditions, disease and pest prevalence and

genetics. Most animals present are adapted to the climate of the state. Cattle (*Bos sp*) are not domesticated but dwarf trypano-tolerant species of sheep (*Ovis aries*) and goats (*Capra aegagrus hircus*) are present. Research work in all areas of livestock production in Rivers State is lacking.

Generally, livestock production has considerable resource requirements which most farmers are not willing to provide (Schiere, Ibrahim and Van Keulen 2002) thus breeding, healthcare, housing, regular feeding and other management practices that could enhance production are often overlooked. Since livestock are not effectively housed, fed and managed they tend to become a nuisance in the community destroying crops in farm lands and making a mess around the environment. In such cases, they are considered liabilities rather than assets to the farm household (Schiere, Ibrahim and Van Keulen 2002). Despite these and other constraints on the livestock industry, it still has a lot of potential for improvement and growth.

2.4.3 Fisheries in Rivers State

There is a high occurrence of fish and shellfish of various species in the waters of the Eastern Niger Delta with about 37 fish species occurring in marine waters while 12 occur in the fresh water areas (Chinda 2002). Fishing is mostly undertaken in main river channels, mangrove flats, tributaries and headwaters and barrier island swamps (freshwater). Fish and other aquatic food usually migrate with weather conditions. Some fish move either with or against the direction of the current but most fish also migrate to the surface during the night to feed, a trend exploited by fishermen who usually prefer to fish at night.

Currently two major kinds of fishery activities are carried out in the waters of Rivers State which extend from the inter-tidal waters to 200km offshore according to international sea laws (Chinda 2002). Firstly, local fishermen carry out artisanal fishing usually with dug-out boats fitted with outboard engines and local drift nets, set nets, cast nets, line hooks, set hooks, basket traps and loglines. Secondly, fishing is done in cultivated ponds in areas where seasonal flooding fills the dug-out pond with sea water trapping fish

within (Otto 2000). Aquaculture is only just developing but has been widely embraced and successful. It is hindered by the availability of high quality fish fingerlings including those of local species (Dickson 2006).

Current fishing systems are largely underdeveloped and labour intensive. Local fishermen exploit the pelagic stock within the 5m depth range which their local gear can reach. Commercial and mechanized fishing trawlers on the other hand, exploit demersal stock with nets towed across the seabed (Chinda 2002). Because of the absence of onboard storage and preservation equipment in their boats, fishermen only spend a short time at sea, about 12-24 hrs, returning to their fishing settlements to process their catch. Only about 20% of the fish caught are consumed in these localities as most are exported to neighbouring cities and states (Chinda 2002).

2.5 Other Constraints to Food Production

Farmers resident in the villages often tend to resist developmental efforts made by the government and other organisations (Ojoko 2000). If an agricultural project is not in agreement with their existing traditions and practices the villagers may not respond favourably, especially, if it will cost them more money or time. Rural people tend to hold on to their ancient values and traditions and will refuse to go along with contrary opinions (Ojoko 2000). A major problem in its own right is the lack of up to date data on the state of agriculture in Rivers State and research on appropriate food production methods.

2.6 Land Use in Rivers State

Agricultural growth aided by population growth has recently increased land use and competition for this and other natural resources (Bourn and Wint 1994). The quantity of food produced in any locality is determined to a large extent by the prevailing land use techniques (McIntire, Bourzat and Pingali 1992) i.e. how the available land is used or allotted to different activities. This is largely dependent on the agro-climate of the area.

Agro-climate in turn influences the types of crops that can be grown successfully and their agronomic characteristics such as productivity, cycle length, ease of mechanisation, and susceptibility to insect pests, diseases and weeds. It also influences livestock production in terms of species, breed, stocking capacity, susceptibility to diseases and individual productivity (McIntire, Bourzat and Pingali 1992).

Rivers State being in the humid zone of SSA, is characterised by little or no cattle, disease resistant small ruminants (because of high tsetse and trypanasomiases prevalence) no irrigation, no mechanization and no organized pastoral systems. The humid zones also support more varied cropping patterns and root crops because of their longer growing season and higher land productivity (McIntire, Bourzat and Pingali 1992).

Figure 2.1 Land use map of Rivers State by Local Government Area (National Bureau of Statistics 2009)

Figure 2.1 shows that about 50% of the state's land is allocated to intensive crop farming by small-holders. Land for agriculture is usually allocated to family members and agriculture is usually on a subsistence level. Agricultural land is usually fragmented, discouraging the efficient use of inputs and mechanization. Women generally are not apportioned land based on customary laws and men have access to 75% of agricultural land (NBS 2006). Although land is available, only 16% of the rural population in Rivers State own their farmland outright i.e. not family/communal land (NBS 2006).

The hinterlands of Rivers State make up the food (crop produce) basket of the state while the riverine areas constitute the fish basket. Food crops and fruits and vegetables grown in the coasts are similar to those grown in the hinterland but in smaller quantities. (Allison-Oguru, Berepubo and Kalio 2002)

2.6 Crop-Livestock Integration as a Means of Improving Food Production

A major key to achieving sustainable food security in humid West Africa is the evolution and development of mixed farming systems (Powell 1994). Mixed farming improves land and water quality and biodiversity and waste products from one system become an input/resource for the other. For instance, crop residues are converted into meat and milk and animal dung is returned to the soil as manure (World Bank 1996). This flow or exchange of resources between crop and livestock sub-systems can be carefully manipulated in order to obtain maximum and optimum total system output and environmental conservation. The productivity of such systems can further be enhanced by continually reducing the amount of external inputs introduced into the system (Powell 1994).

Figure 2.2 by Schiere, Ibrahim and Van Keulen (2002) shows how resources flow from the environment into farm production systems, generating farm resources which could either be exchanged within the system or lost. The flow of resource within a crop-livestock system changes as the intensity of interactions within the system are modified. For instance, a system with livestock on grazing land will begin to recycle less resource if fertilisers are introduced to replace dung. When fewer resources are used, a loss from

the system occurs but this is usually unnoticed as waste management is not usually given much thought and the lost resources are seemingly inexpensive.

Figure 2.2: A generalised diagram showing resource flow in a mixed crop–livestock system (Schiere, Ibrahim and Van Keulen 2002:6)

Mixed farming systems can involve a wide array of cropping systems. This may include a relatively innovative method of farming crops for human consumption intercropped with forage for animal use. A variety of cultivated forage or ley can be intercropped as alley cropping, catch crops, or grass/legume crops. Mixed farming with tree/cover crops can protect the land from run-off and erosion while providing fuel, timber and shade. Catch crops can prevent leaching of nutrients, and legumes can limit the introduction of external resources through fertilisation, by fixing nitrogen from the air. Other crops can

also improve the soil organic matter, nutrient content and the physical status of the soil (Schiere, Ibrahim and Van Keulen 2002). Crop-Livestock integration, if properly managed, promotes sustainability by optimising the relationship between crops and animals while providing both food and feed of high quality (Blackburn 1998).

2.7 Crop-Livestock Integration in other Parts of Nigeria

Crop-livestock integration is not a new concept in Nigeria. It has been successfully practiced for decades and has been a tool for improved food production in the locations discussed below.

2.7.1 Kano State

Kano State in northern Nigeria is a major producer of legumes and cereal crops such as groundnut (*Arachis hypogea*), cowpea (*Vigna unguiculata*), sorghum (*Sorghum bicolour*), millet (*Pennisetum sp*.), maize (*Zea mays*), rice (*Oryza sativa*) and soybean (*Glycine max*). There is also livestock in most household with an average of 14 goats, 7 sheep, 15 poultry birds and 9 cattle per household (Ayoola 2010). The crop farms furnish the livestock with crop residues as livestock feed while the animals provide animal traction and substantial manure for maintaining cropland soil fertility.

In the Kano Closed Settled Zone, farmers practice a highly intensive and labour demanding mixed farming system. In this system, sheep and goats are tethered within the residential compound especially during the short rainy/farming season and fed mostly crop residues and weeds. Manure is then gathered and transported to the fields together with household waste (FAO 2001).

This popular method of CLI has been successful for various reasons. Firstly it has been positively influenced by a high population density which acts as a catalyst for agricultural innovation while also providing the essential labour. Secondly, challenges of transportation are alleviated by the high number of small ruminants and donkeys used

for transportation. Furthermore, farmers live close to their farmlands minimising distance of travel for exchanging crop residues/forage and manure. Thirdly, farmers have total control over the lands they farm and are thus more willing and able to make positive decisions. In addition, oxen and cultivators are in use and owned by a few farmers who also hire them out to generate income. Farmers here also diversify income and cope with environmental and economic risks by mixed farming and mixed cropping and also by engaging in non-farm economic activities during the dry season. The agricultural system in Kano State depends mostly on internal inputs and has proved to be both productive and sustainable (FAO 2001).

2.7.2 Sokoto State

In Sokoto State, north of Nigeria, cattle, donkeys, horses and camels have been used for decades to provide power in food production processes such as in harvesting, processing, transportation and marketing of crop and animal products. Studies also showed that farmers here with draft animals tend to have larger farms as animals provide soil nourishment and reduce manual work load especially when carts or cultivators are attached (Powell, Pearson and Hiernaux 2004).

2.7.3 Benue State

Benue state lies in the middle belt of Nigeria and has been nicknamed the food basket of the nation given that it is agrarian and produces much of the food consumed in different parts of the country. There are two kinds of farmers in Benue state, organic and inorganic farmers. While inorganic farmers utilise chemical fertilisers to maintain soil fertility, the organic farmers make use of plant and animal waste as manure for their fields. This is usually in the form of a locally fabricated bio-digester made using local materials such as a plastic pipe and plastic bottles (Agbulu and Idu 2008). The bio-digester decomposes animal and/or plant waste into liquid/solid by-products. The waste which could be just animal dung from cattle or small ruminants, is mixed with an equal volume of water and

left in the equipment to ferment for between two to three months. Other materials that may be included are fish entrails, chopped alfalfa and sea weed. When the bio-solid is ready, it can also be mixed with mineral salts. It is diluted with water and sieved to remove clogs and then applied to the fields using a back pack sprayer.

2.7.4 Zamfara State

The agricultural system in Zamfara State, north western Nigeria, comprises of extensive crop fields of millet (*Pennisetum ssp*.), groundnut (*Arachis hypogea*), sorghum (*Sorghum bicolour*), cowpea (*Vigna unguiculata*), rice (*Oryza sativa*) and cotton (*Gossypium ssp.*), root crops, vegetables and economic trees. Livestock such as cattle, sheep and goats are also abundant. The Zamfara State Forest Reserve established in 1918 has encouraged CLI by providing a grazing area for livestock during the rainy season or by feeding them crop residues while manure is taken to farmlands for fertility improvement. Generally, two methods of integration are practiced in Zamfara State.

1. LIVESTOCK KEPT WITHIN LIVING QUARTERS

In this system practiced by sedentary farmers, animals are confined within the household compound especially at night and crop residues and concentrates such as bran or cereals provided as feed. This confinement usually takes place during the dry season and could last between 3 to 7 months. The compound is swept daily to gather the voided dung which is placed in a protected heap within or outside the compound. In some cases water is added to the manure heap to accelerate decomposition especially if other items such as cereal stalks, crop residues, household litter and ash have been included to improve its mineral content. At the end of the dry season, the “takin gida” as it is called, is transported to the fields and placed in heaps from where it is broadcast after the first rains just before the fields are ploughed (Hoffmann 2002).

2. LIVESTOCK ALLOWED TO GRAZE ON FIELDS

This form of integration is usually carried out in the form of a manure-crop residue contract between sedentary crop farmers and transhumant nomads of cattle or small

ruminants. The agreement gives the nomadic herder and his animals access to graze the croppers' field for an agreed number of days in exchange for crop residues, money or grain. This system is also favoured by farmers whose own animals may not produce sufficient manure for their large farms. It also creates rapport and friendship between sedentary farmers and the herders who come every year for this purpose. Two forms of contract exist, a stubble grazing contract and a corralling contract.

A stubble grazing contract usually occurs after the harvest of grains and targeted removal of crop residues for sale or storage, and for own livestock grazing. Livestock are then let in to graze on nutritious plant stubbles and other residues on the field. Stubble grazing contracts are practised in the Zamfara Reserve, where farmers have crop residues beyond the needs of their own livestock. For farmers who do not own animals, this is a means to obtain monetary income and manure. During the late dry season when crop residues have become scarce, corralling contracts become popular. In a corralling contract, the animals camp all night on the farm eating whatever is left and depositing urine and dung while they browse on nearby bushes/rangeland in the day. This movement of animals between the rangeland and farmland brings about a net transfer of nutrients to the farmers' fields (Hoffmann 2002).

A study by Omolehin, Steinbach and Hoffmann (2003) showed the effect of CLI in these areas.

- Farmers with their own livestock had better capacity to crop larger areas because they could readily get manure to manage their crop production. Thus mixed farmers followed by croppers involved in manure contracts, had slightly larger mean farm sizes than their counterparts with no means of soil fertility maintenance.

- Mixed farmers, followed by croppers involved in manure contracts also had better yields and consequently better income and their food production had gone beyond subsistence.

- The farms with animals could generate income all year round by sales of animals and animal products and as such had far better income than other categories of farmers.

Farmers who adopted crop-livestock integration gave the following reasons for their decision to do so. In order of importance these are: for manure availability, need for animal traction, need for more income, as savings, need for more food and as part of their tradition (Omolehin, Steinbach and Hoffmann 2003).

2.8 Avenues for Interaction

2.8.1 Crop Residues and Agro-Industrial By-Products

In West Africa, animal feed is mostly limited to forage from pasture/rangelands and fallow lands, crop residues and browse plants (McIntire, Bourzat and Pingali 1992, Powell 1994). Roughage fed to livestock, depending on availability, includes leaves and foliage from multi-purpose trees and shrubs, from certain crop plants and from water plants. Others are the juice from sugar cane, the oil and the fresh fruit from the African oil palm, and the roots from cassava and sweet potato (Sumberg 2003).

Crop residues are an important source of feed for livestock in developing countries especially in small-holder farms. Because they are produced on the farm, they are widely spread through the farm and are cheaply available for livestock, particularly ruminants (Preston 1995). Crop residues are vital livestock feeds during the dry season when forage or pasture is low. Feeds from croplands are of higher quality and animals perform better grazing on these residues than only on natural pastures (Hoffmann 2002). Table 2.3 adapted from that compiled by Adegbola, gives a list of some important crop residues and agricultural by-products common in Nigeria. The table indicates that although these farm resources are useful for improving production through crop-livestock integration, there are a lot of constraints that need to be addressed such as in collection and processing.

Table2.3: Inventory of Some Important Crop Residues and By-Products in Nigeria (Adegbola 1985:1)

Crop residue/ By-product	Current role in animal production	Constraints on use
Molasses	Beef production	Mainly fermented into alcohol
Cocoa pod	Use in ruminant feed experimentally	Collection, drying grinding. Lack of awareness by farmers
Cassava peel	Traditionally used in ruminant diet.	Contains glucoside May require ensiling
saw-dust	Experimental use as rabbit feed in compound diets	Requires processing as silage with poultry manure
Brewers' grain	Use for feed by dairy beef, sheep, goats. Also in poultry feed.	Collection, drying bagging
Wheat offal	Use in beef and poultry production	Mainly exported to Europe
Rice bran	Low levels in starter and grower diets. 30% for weaner pigs.	Not readily available
Maize millings	Supplement for sheep and goats	Not readily available
Maize stover	Dry season feed for cattle, sheep and goats	Poor integration in farming system
Groundnut haulms	Supplement feed to cattle and sheep	Not readily available

Animals can be fed crop residues in their stalls or allowed to graze on stubble in harvested fields. In the fields of the Zamfara State Reserve in Northern Nigeria, livestock are allowed access to the residues after controlled removal of all valuable residues for uncontrolled grazing during the rest of the dry season (Hoffmann 2002). Livestock can also be deliberately allowed to graze whole residues or stubbles on harvested fields either freely or restricted as it suits the farmer or farm. This makes them good controllers of weeds, especially sheep. Crop thinnings can be fed to livestock before the harvest of the main crop residues. Crop residues can also be transported from the farm site and stored for subsequent feeding or sale to livestock farmers (McIntire, Bourzat and Pingali, 1992). If appropriate feeding systems are developed, the common problem of large fluctuations in feed supply and quality will be dealt with.

Agro-industrial by-products result from the processing of agricultural products. They include cakes from oil palm, molasses from sugar cane, pulps from citrus, pineapple and bananas, bran from cereals and blood and bone meal from the slaughter and processing of livestock and fish (Preston 1995). These, unlike crop residues, are geographically restricted to the factory sites and are usually marketed from there to farmers directly or to middle men. They are good sources of animal nutrient requirements and usually low in fibre (Preston 1995). The major challenge in the feeding of agro-industrial by-products and crop residues is that because they are usually bulky, they do not have a good marketing network and are costly to transport from source to area of need (McIntire, Bourzat and Pingali 1992).

2.8.2 Manure/ Animal Dung

Manure has been a traditional means of improving crop production in Nigeria. It is usually the only source for improving land fertility for poor rural farmers with low incomes especially with high cost of fertilisers. Manure application in terms of timing and rates and the response of crops to the manure are influenced by rainfall, temperature, soil type, manure nutrient content and farmer management (Powell 1994, Sumberg 2003). Although manure improves soil conditions, it can also be detrimental to plants if not properly applied. Because there are no set standards for application, problems of nutrient imbalance and toxicity often arise for farmers without technical knowledge or valuable experience.

Utilization of manure and other crop-livestock integration practices within the same production system can increase efficiency and productivity to farmers. Combinations of manure with fertiliser usually result in higher yields than if either is used alone. Livestock can also aid in replenishing soil nutrients lost through harvesting, weeding and cut and carry by deposition of manure and by trampling (Powell 1994, Sumberg 2003). Manure can be obtained from owned animals, from other livestock farmers or through exchange relationships with pastoralists.

2.8.3 Animal Power

Draft animals commonly cattle and donkeys, can contribute to crop production through the provision of power in the various stages of food production, harvesting, processing, transporting and marketing (Powell 1994). The development of cost-effective animal power systems for mixed farming systems can increase food production by alleviating labour shortages and manual work load, improving soil quality, reducing planting delays and increasing crop yields whether it is used in conjunction with manual labour or on its own. Draft animals are in use in northern Nigeria but have not been introduced in the farming systems of Rivers State.

2.9 Factors that Affect Crop-Livestock Integration (CLI)

Despite the potential increases in productivity offered by crop-livestock integration techniques, farmers are often slow to adopt these best practices. A major constraint is competition for land between crops and livestock although this varies across agro-climatic zones. In areas of scarce arable land, and given the fact that farmers prefer to grow crops to livestock, more land is allocated to one (usually crop farming) and specialization may take place.

Crop residues are sometimes used as soil protection and manuring instead of livestock feed (Powell 1994). These practices reduce the available livestock feed, a loss probably compensated for by better harvests and soil conservation (Hoffmann 2002). Also in poor rural farm households or communities, crop residues for animal feed are minimal as every edible plant part that can be gathered is used for human food.

In assessing the evolution and processes of integrating crops and livestock it is important to include its multiple dimensions. Most work done has focussed only on dependent variables without assessing the relationships between these and how they work together to either encourage or discourage CLI. For example, market variables such as distance to markets or quality of road infrastructure may or may not significantly affect the acquisition of crop residues or purchase of agricultural by-products as livestock feeds.

Also, indicators of CLI such as manure use, crop residue utilization, and use of agricultural by-products as livestock feed vary from place to place depending on the environment, local geography and economy. If CLI is judged on a general level, the same effects will not be experienced in all locations and results may be conflicting (Manyong, Okike and Williams 2006). Also, research is lacking to identify specific areas of integration and appropriate methods suitable for the physical, biological and socio-economic environment.

Extension officers although essential, may sometimes themselves become hindrances to crop-livestock integration. This is because they tend to emphasize technical approaches to agricultural improvement involving chemical fertilizers and improved crop varieties, which in the long term, may negatively affect the adoption of CLI among farmers (Manyong, Okike and Williams 2006). Furthermore, the agricultural extension system at work in Nigeria places a burden on a single agent, overseeing various communities and who is expected to carry messages on all aspects of agriculture including crop production, forestry, fishery and livestock production. These agents are often not sufficiently grounded in knowledge and skill in the various areas their activities are supposed to cover (Nworgu 2006, Ojoko 2000).

2.10 Chapter Summary

Food security in Sub-Saharan Africa is influenced by food availability, food stability and access to good food. Nigerian agriculture has further being influenced by inept government policies and programmes and poor development of effective agricultural systems. Basic systems of agriculture are practiced in Rivers State. Crop farming is carried out using simple hand tools, animals are raised under extensive systems and fishing is also carried out using traditional systems. These have been seen to constrain food production and CLI is not practiced even though it has been successful in other states in Nigeria. However more research is needed to identify and exploit variables and indicators of CLI in Rivers State to successfully proffer a system that would be effective in improving production of crops, livestock and fish.

Chapter 3

METHODOLOGY

3.1 Introduction

This chapter sets out the research strategy employed by the researcher to achieve the objectives and gather appropriate data. It also describes the focus of the research and defends the choice of design and data collection methods used in the study.

3.2 Research Focus and Questions

The study focused on characterising existing food production techniques and practices employed by local farmers residing in rural areas of Rivers State, particularly the integration of crop and livestock production in these settings. Based on this, exploratory research questions were set as follows

- What is the present level of food production generated within the state?
    - What are the methods employed by the rural farmers in food production?
    - What farm resources are available to farmers?
    - What form of Crop-Livestock Integration, if any, is generally practised?
- How efficient are existing technologies utilised in small-holder farms in terms of:
    - Technologies in crop farming
    - Technologies in Livestock Farming
    - Technologies in food preservation and processing
- What can be done for more efficient use of resources to improve/boost production?

- How can crops and livestock be integrated to improve production within this setting?

- What can farmers do themselves?

- What can other stakeholders such as government and private investors do?

Exploratory research questions aid in gaining better understanding and insights, different perspectives and assessment of occurrences within the area of interest (Robson 2002). These areas of concern and focus were identified from the literature, which suggests that small-holder farmers in rural areas could increase total food production output using improved systems and techniques (Nworgu 2006). Also important was the researcher's concern about the continuing trend of high food importation into the state. This study set out to propose alternative and more sustainable methods of farming that will boost food production in the state while making better use of on-farm resources.

3.3 Research Strategy and Design

A flexible design strategy was employed in this study as it incorporates different strategies for data collection (Robson 2002). Flexible/qualitative designs are better adapted to real world situations especially involving work in the field reporting accounts and results from the perspective of the farmers in this case (Singleton and Straits 2005). It is also suitable for this research because it can be employed to achieve credible results even in small-scale studies (O' Leary 2005, Sarantakos 2005).

Under this design strategy, the study was conducted using a case study approach working with two local communities. A pilot study was conducted in each community before the main research data was collected through a combination of survey questionnaires, interviews and observation. A chart highlighting the research data collection methods is presented in Figure 3.1

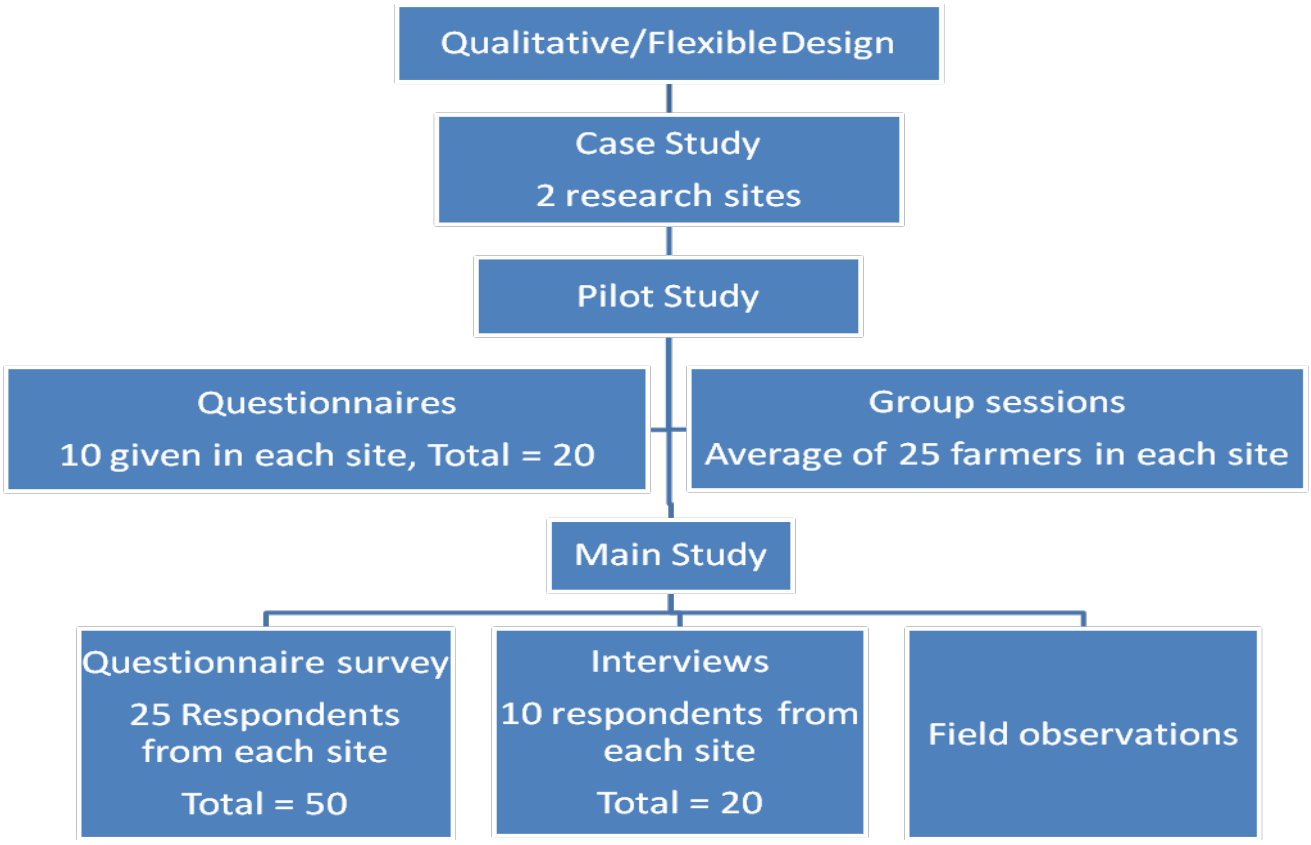

Figure 3.1: Organisation Chart of Research Strategy

3.3.1 Case Study

A case study is a concise investigation into an issue or case, in this instance, the community under study. It is a detailed study in a quest to achieve thorough knowledge about the setting or group (O' Leary 2005, Robson 2002). Because the cases were also exploratory, new understandings and answers were also brought to light since the study is carried out within the context of the case and community. Two research sites were studied as separate cases, Abua in Abua/Odual Local Government Area (LGA) and Oyorokoto in Andoni LGA. Each case was made up of the farmers within the community who in case studies are considered as experts in their own field rather than just sources of data (Sarantakos 2005). Both sites were studied using the same criteria and methods. Particulars for selecting key informants and respondents are discussed below. Because a

relationship was developed with the participants over time during the case studies, a better holistic understanding of their experiences was achieved. These communities represented the two main geographical and climatic terrains present in the state as it would not be possible to visit all LGAs. Using only two communities also reduced researcher stress in travelling, access to facilities and financial burden (O' Leary 2005).

3.3.2 Pilot Study

An extensive pilot survey was undertaken before the main study was devised. The pilot survey was aimed at assessing real needs of the farmers in relation to the research and testing the proposed survey and data collection methods (Hoggart, Lees and Davies 2002). It was also done as a pre-test of the survey questionnaire design and format, length and proposed questions to test the range of responses, appropriateness to the audience and whether it achieves its aims (Flowerdew and Martin 2005, Hay 2005, Hoggart, Lees and Davies 2002). The pilot study also gave the researcher the opportunity to assess the questions/ response categories from the respondents' perspective, to generate mini data to work on before the main results and to assess the effectiveness and suitability of the proposed data collection methods and instruments (Cloke *et al*. 2004). In addition, it helped ascertain the feasibility as well as estimate the cost and duration of main study and to familiarise the researcher with the research environment (Robson 2002). It exposed likely constraints that might be encountered during the main study such as transportation, access, response rate and bias and other possible weaknesses and inadequacies so they could be corrected before the main study (O' Leary 2005, Sarantakos 2005). The informal interactions with residents of the community also highlighted more research issues and questions and helped shape the final research questions, methodologies and strategies (Ite 1997).

This pilot study was essential even though the researcher was a native of the state and had been to both research sites on previous occasions. However, those visits were merely social and not deductive and changes had subsequently occurred and research issues were different from previous perceptions. The pilot study commenced with visits to the

Rivers State Ministry of Agriculture and the State's chapter of the Special Programme for Food Security (SPFS). This initial meeting generated subsequent visits to, and survey of some food producing communities where informal interviews with farmers and farming co-operatives were conducted.

The mini study involved a pilot group of an average of 25 farmers from each sample site. The farmers were a mix of livestock farmers, fishermen, crop farmers and mixed farmers. 10 questionnaires containing proposed questions for the final questionnaire were also trialled in mini interviews and group discussions to assess their comprehension by the local farmers. Farmers involved in the pilot were similar to those who would eventually take part in the main study in terms of age, financial capabilities, farming systems and availability. Some of these farmers were also involved in the main study.

3.3.3 Target Population and Sample Size

Sampling was done to enable the researcher to study a relatively small part of the target population and yet obtain representative data (Hoggart, Lees and Davies 2002, Singleton and Straits 2005). Sampling was also done to save time, labour and money and to improve accuracy (Sarantakos 2005).

The method of sample/participant selection for the study could be said to be a combination of both purposive and random sampling. The research was aimed at local farmers and thus the survey population for the study was drawn from this group within the case study communities. The case study communities were themselves hand-picked by the researcher on the basis that they were major food producers within the state with easy access for the researcher through the involvement of the State's Ministry of Agriculture. These farmers were already working with the Federal Governments' Food Security Programme and the State's office provided assistance in accessing them.

Twenty-five farmers from each site were chosen at random across farm cooperatives represented in the communities. These received and completed questionnaires. On the basis of the information gathered from the questionnaires, ten respondents to be

interviewed from each site were selected by the researcher. Those selected met a combination of criteria including relatively large farm size, presence of both crop and livestock activities irrespective of whether they were raised together or not, presence of aquaculture or interest in this, and also if there was any unique or unusual responses in questionnaires. The researcher also employed unobtrusive observation of farms and agricultural activities carried out by farm families to corroborate what was written down with what was actually being done.

3.4 Data Collection

Rivers State is a very diverse state comprising twenty-three Local Government Areas (LGAs) and farming practices vary with location. A combination of methods was used in the study to collate data. This is typical of flexible exploratory studies and increases validity and credibility of research results (O'Leary 2005, Robson 2002).

3.4.1 Survey Questionnaires

Surveys can reach a large number of participants, represent a larger population, allow for comparison and generate qualitative data (O'Leary 2005). The survey questionnaires were designed with research questions in mind. Questionnaires were designed in simple format with easy to understand grammar and bold typefaces. This was to ensure that the audience, made up of rural people did not find it difficult to complete. However, some respondents required assistance from their farm cooperative heads or more educated people to read out and fill in the questionnaires. Questions were mainly open ended but included explanations and instructions for better understanding. Open-ended questions allow freedom to express feelings and thoughts especially with complex issues and offer more detail and information in areas not foreseen by the researcher (Sarantakos 2005). This may have been hampered in cases where the questionnaires were filled by other people as interpreters may not have been able to fully express the respondents' concerns and interests.

The questionnaire covered aspects of farm and farmer including basic bio-data, farming systems and methods, farmer experiences and food production challenges, processing techniques and challenges, use of modern equipment and technology, wastes and/or residues generated from farm(s) and their handling, sufficiency of food produced, interests in farming and how the farm is financially supported (Appendix 2). Unfortunately, the use of the word "livestock" in the questionnaire seemed to puzzle some farmers who failed to indicate the number of animals they had since they were not familiar with the word. Thus the data received in the questionnaire was not an accurate representation of livestock numbers in each household. When conducting research in local areas one must use familiar terminology as a better word to use would have been "Animal". The researcher attempted to rectify this by asking for animal numbers among those interviewed.

3.4.2 Interviews

Interviews at both sites were carried out at a time and venue convenient to farmers and took place in public places usually the community or school hall. A message was sent through the assisting government personnel and a convenient date and time chosen by the farmers' co-operatives to meet for interviews. Farmers were interviewed in a face to face semi-structured style (Hay 2005, Robson 2002) based on their responses as the interview progressed in a mix of pidgin and English language. The general pattern was to gain as much knowledge of their personal struggles with maintaining and improving food production. They were also encouraged to talk about their attempts at integrated farming whether it be crop-livestock, crop-fishery, livestock-fishery, or in rare cases crop-livestock-fishery. The researcher was also able to gather some more data not recorded in questionnaires such as the number of animals owned by farmers who failed to indicate this.

The aim of the interview was not to generalize but to understand how individual people experienced and comprehended their own lives and agricultural activities (Flowerdew and Martin 2005). Research interviews are important to fill any gap in knowledge,

investigate complex behaviours, collect a diversity of opinion and experiences within a group, know what is relevant to the informant and also gives the informant the opportunity to reflect on beliefs, experiences and the research project (Hay 2005).

3.4.3 Observations

Direct field observation of the chosen farms was undertaken by the researcher. The observations were planned, methodically carried out and intended to extract meaningful interpretations. The researcher as a participant observer in a natural setting, followed the farmers in their day-to-day activities in the communities. This was made easier by the fact that the researcher had over time developed a rapport with the farmers from the pilot phase through interviews. More depth was provided through informal conversations with key respondents (Singleton and Straits 2005). All data obtained in the field was recorded in a note book.

Photographs were taken with the permission of the respondents and done after interviews to avoid disruption. The farm visits were always carried out with the permission and presence of the farmer and the assisting government personnel and sometimes with the resident/overseeing extension agents. For safety and ethical reasons, the researcher did not wander unto farms uninvited and unaccompanied.

3.5 Research Sites

3.5.1 Choice of Research Sites

Rivers State consists of 23 Local Government Areas (LGAs) with agricultural and ecological environments of two major kinds; coastal and inland (Figure 3.2). The LGAs in the coastal regions are characterized by large bodies of water and rivers leading to the Atlantic Ocean. They also possess rain forests and mangroves and land suitable for farming. On the other hand, LGAs in the inland areas have extensive land for farming and fewer water bodies.

Fig 3.2: Map of Rivers State showing LGAs and ethnic groups (National Bureau of Statistics 2009)

The two LGAs chosen for this study were Abua/Odual LGA, located in the inland and Andoni LGA, located in the coasts. These two LGAs were selected because of their food producing capabilities as well as their ecological representativeness. They were also chosen because of their ongoing participation in the Special Programme for Food Security (SPFS) being sponsored by the Federal Government of Nigeria in conjunction with the Food and Agriculture Organization (FAO) of the United Nations. Farmers involved in the SPFS are more willing to lend themselves to research work having being beneficiaries of existing agricultural projects. The researcher was accompanied on all visits to the sites including interviews and farm observations by the State's Director of the programme. This facilitated the reception of the researcher given that the introduction was made by a well known and respected agricultural worker as experienced by Batterbury (1997). The research cut across different communities in each LGA.

3.5.2 Agricultural Structure of Research Households

A typical farm household consists of a man, his wife (or wives), their children and relatives (Allison-Oguru, Berepubo and Kalio 2002). Some households may also have women as heads. Although the members of the household provide the inputs needed for agricultural production, the principal decision maker of any agricultural enterprise is the farm owner who may or not be a household head. Production practices such as tilling, weeding, planting and harvesting times are decided by the farm owner. Based on the fore going, the research did not focus on household farming but on individual farmers who make their own decisions and have their own farming enterprises. Average age of farmers in Rivers State is 35 years with the active age group being between 25 and 50 (Allison-Oguru, Berepubo and Kalio 2002).

An animal and its offspring is the responsibility of the owner though its care such as in feeding and safety is a shared duty among family members. Fish and other sea products are the property of whoever made the catch. Crop proceeds and meat products are also under the authority of the farm head. In some cases, there may be an existing agreement to share farm proceeds for example as a payment for manual labour or for hiring of fishing boat and gear. Where processing may be essential as in the case of cassava and oil palm or sea products, the farmer might decide to sell off the produce for immediate cash or may use household labour to process. Where processing is carried out by women and children of the household, they may obtain by-products for their own use for example kernels and nuts from oil palm, certain offal and extremities from livestock.

Family labour is encouraged to maximise profit which is used to economically improve the household. In some cases, more than one person in a family may be farm owners and in this case labour is often hired by one or both parties for farming operations or family labour is used on agreed dates. In Rivers State farming systems, manual labour is utilized in all activities such as in clearing the land, tilling, planting, weeding, manure application, harvesting and processing. Where a large expanse of land is involved, the farmer may employ workers to get the job done in good time.

Under Rivers State customary law, land is given free to sons (Otto 2000). Women, with due permission, can farm on lands belonging to their sons, husbands, fathers or brothers though this may not be a permanent farm. If a farmer needs more suitable land for farming or to expand an existing farm, he/she may have to purchase it or enter into a lease agreement with the land owner or community.

3.5.2 Andoni LGA

Andoni Local Government Area is located on the shorelines of the Atlantic Ocean and made up of islands separated by creeks and rivers. In the census of 2006, it had a population of 211,009 people made up of 112,441 males and 98,568 females (NBS 2006b). Fishing has always been the major occupation of the people from early times. Crop farming was not common in pre-colonial Andoni probably because they felt the exchange of excess fish for other foods with farmers/traders from the hinterland was more profitable and less labour intensive and also because of the menace of wild animals. Farming of oil palm and plantations of cocoa, rubber and cashew began later when they observed the profitability of this with neighbouring villages (Ejituwu 1991).

Fishing is undertaken year round and is more intense in the dry season but in recent times, has been threatened by the invasion of the Nypa palm (*Raphia regalis*) and oil pollution from ongoing oil exploration activities in the Niger delta. This has also led to over fishing in territorial waters because of the increasing incidence of poverty and hunger in the region (Ejituwu 1991). Fishing is usually left to the men folk while women gather shell fish and prawns in smaller creeks. Fish caught in their waters are found all over the state and neighbouring states and even internationally.

Fishermen usually go out in groups staying in fishing camps to clean and dry fish and also sell to traders from the hinterland. These fishing ports are made up of people from different villages who return home at the end of a fishing season. Oyorokoto is one of these fishing settlements and is probably the largest of its kind in West Africa (Ejituwu 1991). Fishermen here also engage in farming either at home in their native villages, or in the port itself as some do not go back home all year. It was therefore an ideal place for

the researcher to visit and meet with fishermen and farmers from different villages of the LGA.

The flat lands of Andoni also encourage the farming of cassava, yam, maize, vegetables and herbs. However, some land is not suitable for crop farming because of high salinity or high water levels. Cultivated food crops are usually sold and processed locally and to neighbouring LGAs. Crop farming is still threatened by wild animals but farmers have devised various means to deal with this. Domesticated livestock include sheep, goats, pigs, chickens and ducks.

The people speak one language, Obolo, and still have poorly developed infrastructure owing largely to geographic inaccessibility and bad governance of previous administrations. Roads and bridges linking the villages to the other parts of the state by land were still under construction at the time of undertaking this research. Access to the villages therefore was by boat. Basic electricity and tap water is still lacking in most villages and this has posed a major agricultural challenge especially in the area of storage of farm products. The farmers, however, have addressed the challenges by adapting local and natural methods of preservation. For example, fish is dried or roasted over fire and sold as “dry” fish.

Some farmers receive grants and loans from the government and from cooperative societies while a great deal are self financing. Farming is usually a family enterprise involving every member of the household each having his/her own designated duties.

3.5.3 Abua in Abua/Odual LGA

Abua/Odual LGA has a total population of 282,988 with 150,904 males and 132,084 females (NBS 2006b). Abuan describes the ethnic group and language of the Abua people and is made up of villages and communities surrounded by rivers and forest and other hinterland communities. This makes it an incomplete island and a major link between the more hinterland and coastal communities around it, which are a great influence on the demand for agricultural products (Otto 2000). Abua has extensive flat land surfaces with

high yielding soil supported by underground water. This makes it a major food crop producing area in the state attracting traders and business people. Farmers here grow a wide range of crops including cassava, yam, maize, oil palm, coconut, and vegetables. Farming is done all year and the main farming system is shifting cultivation/bush fallow. However, increasing urbanization and population pressure has led to land becoming rare and acquisition difficult, reducing fallow periods from 6 to about 3 years (Otto 2000).

Other popular forms of agriculture in Abua are animal husbandry, fishing and forestry and processing industries for oil palm and rubber. Most farmers rear livestock domestically but a few farmers now rear poultry and pigs at larger scales. Common domestic animals are sheep, goats and chickens. Fishing is usually in the wild but also undertaken in cultivated ponds which are traditional and enable fish to be trapped in tributaries and in dug-out ponds when the river overflows (Otto 2000). There is also growing interest in aquaculture and experimental fish farms have been set up by some farmers.

Most farmers sell their produce to local marketers of food and their produce is found in all major markets in the city and in neighbouring states. Some farmers are also involved in processing of their produce for example cassava is processed into garri, a well known Nigerian staple meal and oil palm is processed into palm oil. Farmers here also receive grants and loans from the government and cooperatives.

3.6 Ethical Considerations and Clearance

Because issues of participants' privacy, confidentiality, safety, integrity, and complete consent are more pronounced in qualitative research, the researcher went through strict ethical procedures (Cloke *et al*. 2004, O'leary 2005) before and during the study. Participants' consent was sought before the study was commenced. A concise document (Participant Information Sheet, Appendix 3) outlining the nature of the research and the roles the respondents were to play was also given and this was reinforced verbally. Participating farmers consequently gave their consent by signing an informed consent form produced under Coventry University's ethical guidelines. All other ethical issues and considerations set out by the Institution were also met. There was no perceived risk to

participants as the study did not involve experiments. Observations were “pure” as the researcher did not disrupt nor request farmers to make changes to farming activities. In addition, the research fulfilled the ethical need to have the potential of doing some good to the researched (Madge 1997) as it aims to suggest better food production strategies.

3.7 Ethnicity

The ethnic groups in Rivers State are very diverse with about 13 ethnic sub-groups within the 3 major ethnic groups (Figure 3.2) and over 20 indigenous languages (Kari 2002). Thus, in both LGAs separate languages are spoken. The Andonis speak the Obolo language, while the people of Abua/Odual speak Abuan/Oduan. People of both areas are traditionally hospitable and welcoming. The researcher, being of Rivers State origin, was gladly welcomed and accepted into their midst. The Andonis were particularly glad since the researcher is a native of one of its villages.

Most of the farmers could communicate in English but those who could not, were able to communicate effectively in Pidgin. The researcher employed the use of the latter in surveys and in chats with the farmers since most of the farmers were more comfortable with it. However, in Andoni, the occasional use of the Obolo language by the researcher was helpful in creating rapport. It also made the respondents more comfortable and more willing to divulge information which they may not have shared with “outsiders”. As Ejituwu (1991) experienced in the gathering of oral history in Andoni, being a native, had several advantages and disadvantages. An advantage was that an interpreter was not required and, because the researcher had an understanding of the language, customs, community organisation and thought system of the people, a better view was obtained. A disadvantage he experienced in obtaining data from another village was the distrust and suspicion with which he was perceived by people from other communities different from his own. Fortunately, this was not experienced in this study because Oyorokoto, where major information was collected does not belong to any one section but is made up of people from different communities in Andoni.

Generally in Rivers State, indigenes are given preferential treatment to non-indigenes. This norm worked positively in favour of the researcher as both government offices and officers, including the researched were willing to help. The researcher was seen as one of their own who had achieved a good education and was able to provide something back to the local people. As Hoggart, Lees and Davies (2002) noted, doing research within one's own culture can be either positive or negative or both. In this case, the researcher was expected to be familiar with traditions and cultures of the people and not to behave in a manner that was too westernized.

3.8 Positionality and Reflexivity of the Researcher

Reflexivity is self awareness and constant scrutiny of the researcher and research process (Hay 2005, Sarantakos 2005) and influences communication with the researched (Howard 1997). The researcher, as an educated young female from the city was greeted with certain uncertainty at the first meetings with local farmers. This phase quickly passed after an introduction was done in which the researcher was presented as a local girl who had been to school. This however highlighted the researcher as one who could potentially help their situation and give a message to the government on their behalf. However, it was made clear that the researcher's studies were independent of the government and there was no guarantee that outcomes and recommendations would be adopted by the government or those concerned so as not to generate false expectations. Another issue of perceived power over the respondents was in the belief that the researcher was affluent and influential (Howard 1997, Robson 1997) especially because she bore the same surname as a popular influential politician in the state. The researcher tried to play this down by introducing herself during interviews with just her first name to avoid discussions stemming from "oh are you related to…" It was also stressed that she was not a politician and was there purely to gather data for academic purposes.

Agriculture in Rivers State is heavily dependent on the women folk as much of the farm labour and processing relies on them. It was therefore uncomplicated to interact and receive information from the female farmers in their routines. The researcher's gender

made it easier to communicate with the women folk as Robson (1997) observed. Communication with males was also made easy with the presence of the State's Director of the SPFS with whom they were already familiar and because the researcher appeared smart and responsible. The researcher was seen as an example of a female who could achieve something as opposed to the ancient cultural belief that a woman's place was in the home. The researcher was respected in the farming meetings as an educated person but this was balanced with by the fact that the farmers were older.

Generally, being a Nigerian and an indigene of the state, the researcher felt more like an insider and was seen as such by the farmers who expected her to understand their situations better than an outsider would. This also led to a certain level of expectation of how the research process could provide for the individuals involved in the study in the form of payments or gifts or other favours, as experienced by Ite (1997) doing fieldwork in Cross River State, Nigeria.

The researcher was reflexive in attempting to put her own knowledge, background, position and values aside in order to see from the participants' perspectives without bias (Cloke *et al*. 2004). The use of a qualitative method of inquiry also gave participants more power and some level of control over the results.

3.9 Analysis and Triangulation of Data

All of the data were exploratory and the analysis sought to identify key trends and differences within and between the research sites. Primary qualitative data was generated from questionnaires, interview responses and field notes. These were analysed using the Miles and Huberman (1994) approach of data reduction, data display and conclusion drawing. This approach is suited to research in the real world exploring the relationships between activities especially in case studies.

Firstly, the data were reduced using summary sheets, outlining processed qualitative data from each site and assigning simple codes to major points of interest. From the summary sheets, the results were easy to display through table matrices and charts highlighting

results such as frequency distributions. Findings were also displayed through pictures taken during farm observations. These methods of data display were used because they are more easily understood and show a wide range of results (Robson 2002). Conclusions were drawn from summary sheets and tables by noting frequencies of occurrence, patterns and relationships. The arithmetic mean was used to measure central tendency or level of distribution among results for any particular case or criteria while the range was used to show variability.

Multiple sources of data were triangulated to strengthen the validity of results. To achieve this, the researcher compared and contrasted answers, notes and results from the preliminary studies, questionnaires and subsequent interviews. These were also adequately studied before the field observations and guided the researcher's choice of farms to visit. Because all results were put together in context, similarities and exceptions were noted and the research results were more conclusive.

3.10 Chapter Summary

A flexible design strategy was employed for the research and conducted using a case study approach. This methodology involved data collection through various means including a pilot study, questionnaire survey, interviews and field observations carried out in that order. All data were analysed using standard guidelines. Two case study communities were chosen for the study noting the diversity in their ecological and geographical components. Other considerations were also put in perspective such as ethics, ethnicity and positionality of the researcher.

CHAPTER 4

RESULTS

4.1 Introduction

The chapter begins with an overview of the socio-economic characteristics of the farmers involved in the research, presenting background information on their status and demographics. This is followed by the findings on crop, livestock and fish production as observed by the researcher and as a result of questionnaires and interviews. It was important to note the actual crops and livestock common in the research areas and methods of husbandry including fishing methods as these would determine crop-livestock integration practices. The general production, preservation and processing of food is discussed in order to assess agricultural sustainability and the feasibility of CLI. Next is a short description of the level of crop livestock integration carried out in the research locations, followed by the section on agricultural wastes/residues produced in these farming systems and how farmers handled them. Some limiting factors preventing integration of wastes into farming systems are also outlined. The factors influencing food (crops, meat and fish) production as identified by farmers are also discussed. This is important to understand the farmers' perceived limitations and site specific challenges so as to develop effective management solutions for improving food production in the region by incorporating crop-livestock integration.

4.2 General Socio-economic Status of Respondents

4.2.1 Age Distribution

The age of farmers surveyed in Abua, ranged from 21-70 with an average of 37.9 and from 30-57 with an average of 36 in Andoni. Figure 4.1 clearly indicates that the more active age group in farming is between 31-40 in Abua and 31-50 in Andoni with few farmers over 50 still in active farming activities. Farmers surveyed in both sites had also spent varying amounts of time in farming (Table 4.1). Most were born into farming and have continued in the profession as adults.

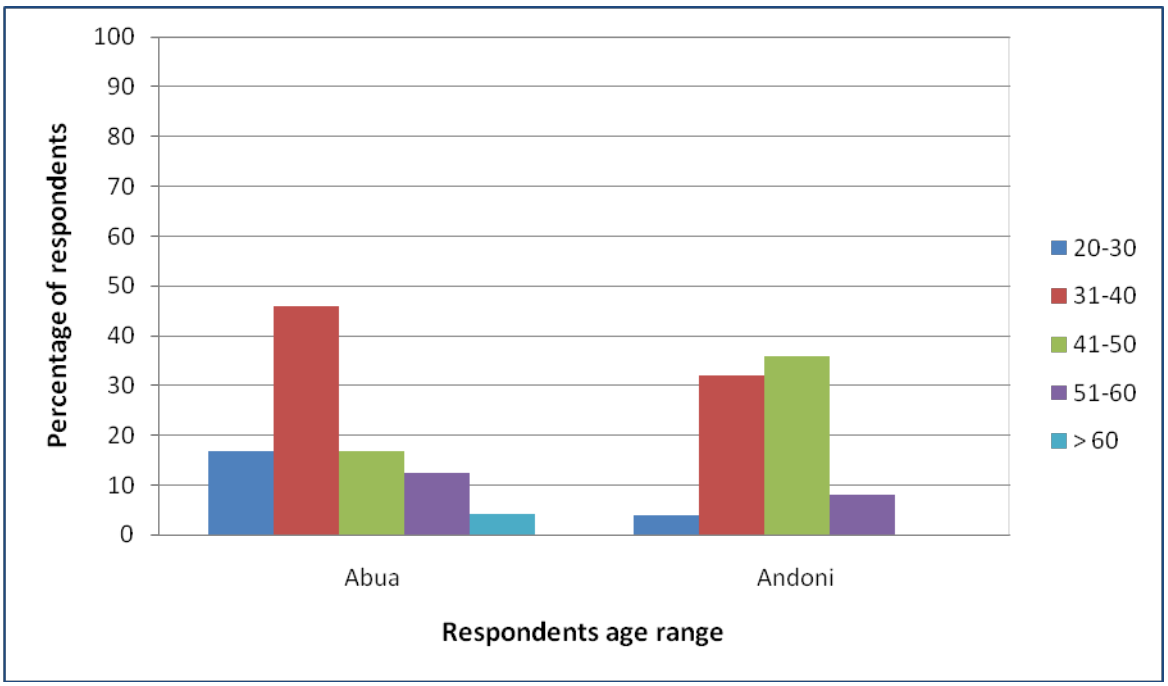

Fig 4.1: Percentage age distribution of farmers surveyed

Table 4.1: Distribution of number of years in farming

Farming period	Abua (n=24)	Andoni (n=25)
4-9 years	4 farmers	-
10-20 years	16 farmers	10 farmers
21-30 years	4 farmers	12 farmers
Preferred not to answer	0	3

4.2.2 Gender

In Abua, 17 of the respondents were male while 7 females owned and managed their own farms. The number of females was lower in Andoni with only one female farmer among 24 male respondents (Figure 4.2). Women were present during group discussions but were considerably fewer than men. Although the women were indispensable in agricultural production in farm households, they were not usually in a position to make decisions affecting farm practices except in cases where they ran their own farms. Men were mainly involved in clearing of farmland/ tilling before planting and in the planting of labour-intensive crops like yam, cassava and other root crops. Women were sometimes

engaged in weeding and planting of shallow crops like maize and pineapple. Fishing was usually left to the men but its processing including gutting and drying was almost exclusively done by women except when large fish or shark are caught. The processing of cassava such as the peeling, grating and cooking was also mainly done by women and children.

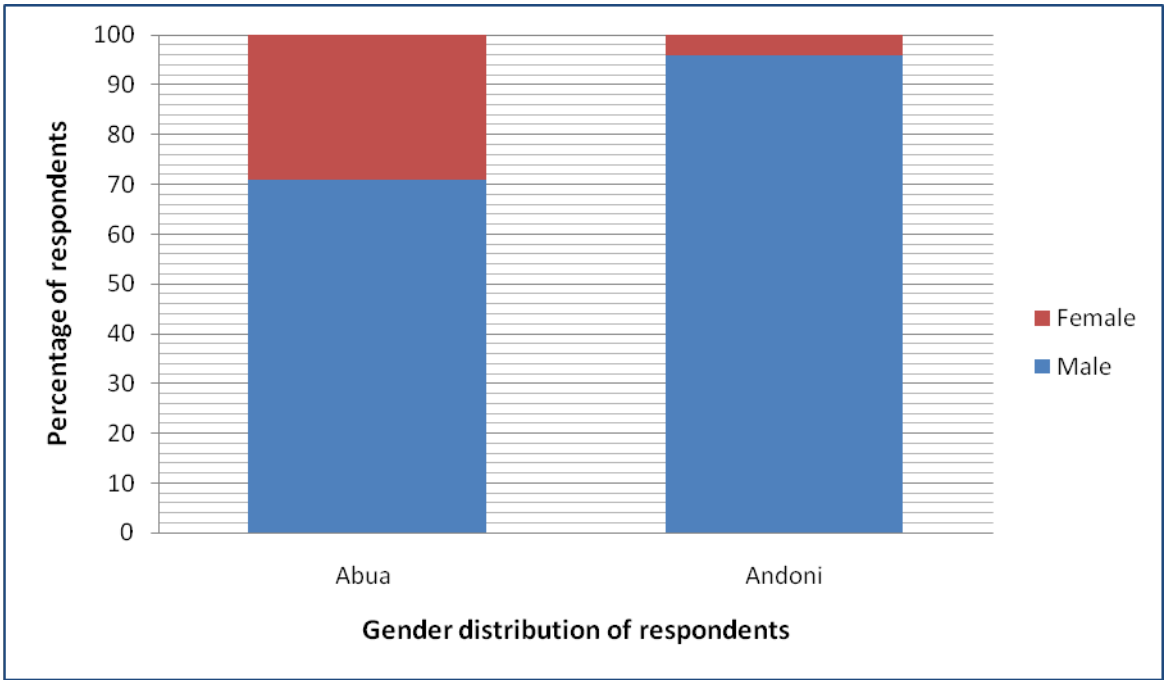

Figure 4.2: Gender distribution of respondents

4.2.3 Educational Status

Although this was not a part of the questionnaire, the researcher observed through group sessions and interviews that only about 50% of the farmers had obtained varying levels of primary school education, of which some had attained the state's teacher training and were currently in service. Only one respondent (in his 20s) was pursuing higher education in the state's university. Generally all could communicate in Pidgin English.

4.3 Food Production

4.3.1 Crops

The potential of Rivers State to produce a wide variety of food crops has been established in previous chapters. However, the surveys carried out in this study showed that only a few crops were given priority by farmers. The major crops grown and the number of respondents involved in growing them are listed in Table 4.2. Cassava was most popular among farmers and was farmed both at a large scale and by subsistence farmers. It is a root/tuber crop like yam but is not as labour intensive in production. Farmers interviewed said they preferred producing cassava for this reason even though a good harvest of yam was usually more profitable.

Table 4.2: Crops grown by respondents and number of farmers involved in their cultivation

Crop	Abua (n=24)	Andoni (n=9)
Cassava (*Manihot esculentus*)	22	9
Plantain (*Musa paradisiaca*)	12	5
Yam (*Discorea rotundata*)	8	3
Maize/corn (*Zea Mays*)	2	4
Pineapple (*Ananas comosus)*	8	1
Oil palm (*Elaeis guineensis*)	6	1
Leafy Vegetables	4	4
Rubber (*Hevea brasiliensis*)	3	0
Melon/egusi (*Cucumeropsis mannii*)	1	1
Cocoyam (*Colocasia esculenta*)	10	0
Coconut (*Cocos nucifera*)	0	1
Water melon (*Citrillus lanatus*)	0	1
Mango (*Mangifera indica*)	0	1
Orange (*Citrus aurantium*)	0	1
Okra (*Abelmoschus esculentus*)	0	1

Plantain was the most widely planted tree crop and required little labour and attention. Oil palm was also popular and usually grown in large plantations requiring extensive land. It was sometimes intercropped with other food crops mostly by farmers who had only a few oil palm trees in their farms. The indigenous African oil palm (*Elaeis guineensis*) with a lengthy growing period of a minimum of four years before first harvest is still popular,

thus poor farmers who need immediate returns did not venture into major oil palm production. Rubber, once a major tree/cash crop of the region had unfortunately reduced in popularity among local farmers and only three farmers acknowledged growing it and even then just a few trees instead of large plantations.

Pineapple seemed to be given more priority by farmers although other fruits like oranges, mangoes, bananas and guavas are also grown. Leafy vegetables like fluted pumpkin (*Telfaria occidentalis*) and bitter leaf (*Vernonia anygelalina*) were usually grown by women. Water leaf (*Talinum triangulare*) grows wild but is still part of the commercial trade.

Although Andoni is on the coast and is just being connected by road to major cities in the state, crop farming is still carried out here on an impressive scale. Much of what was farmed in the hinterland was also cultivated in Andoni, although mostly on a smaller scale. Large-scale crop farming was practiced by a few and was successful as observed in Box 4.1. Crop farming was done by nine farmers involved in the survey, farming mainly cassava. Coconut and plantain were the major tree crops as they are adapted to the natural environment. Leaf vegetables and spices such as basil (scent leaves) and chillies (peppers) are found in most households and maize (corn) is popular for its short growing season. Water melon had just been successfully introduced by one of the farmers and had proved profitable.

Box 4.1: Farmer X in Andoni LGA farming only crops on a large scale

Farmer X has been a crop farmer in Andoni for 25 years. Although he is slightly above the average age of active farmers in this region, he is still actively farming and is one of the few educated farmers. He has been a consistent farmer of food crops and has grown a wide range of crops over the years. He currently grows cassava, melon, maize, coconut and plantain and is one of the pioneer farmers to introduce water melon. He intends to expand this in subsequent seasons. His 4.3 ha farm is above the average 1.5 ha owned by most farmers and is located in Agwut-obolo village which has good soil qualities for planting, better than those in Oyorokoto or locations closest to the ocean. He is unusual because most farmers in Andoni only farm on a small scale and supplement with fishing but he has consistently farmed only crops and makes good profits. He insists that agriculture in Andoni and in Rivers State as a whole could be improved considerably with more support from the State's government authority.

Farmers often blamed poor soil and adverse weather conditions for the inability of some crops to do well in the region. The researcher was also informed that rice trials sponsored by the Federal Government had been promising in the swamps of Andoni but had not been tried further nor embraced by farmers, although some farmers suggested that they would be keen to take this further if given proper support.

Generally, crop farming was a major occupation in both Local Government Areas, and very labour intensive. Traditional crop farming implements including hoes (urok in Andoni), machetes (oge in Andoni), cut-lasses, axes, pick-axes and shovels, some of them locally produced, were still in use (Figure 4.3). Mechanization in these small-holder traditional cropping systems was non-existent. Farming was done in shifting cultivation with a fallow period of two to four years. Most crops were intercropped and there was usually no provision to paddock animals within or around farms. Generally, farming patterns were decided by the farmer with regard to his/her available farmland.

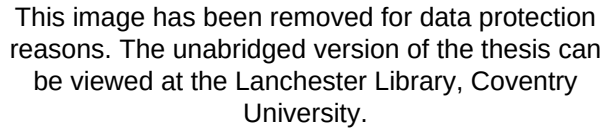

Fig 4.3: Cassava farm in Abua showing local implements used by women and children

4.3.1.1 STORAGE, PRESERVATION AND PROCESSING OF FOOD CROPS

Farmers still used traditional means of preserving food as outlined in Table 4.3 especially since electricity was a scarce resource in the rural locations. Crops, once harvested, were marketed or sold within the shortest time possible ranging from one to seven days depending on the nature/perish-ability of the product. Most farmers surveyed had barns for storing tubers like cassava, yams and cocoyams. This storage method, however, was not very effective with cassava having a very short post-harvest life span of about five days especially in humid conditions. After harvest of cassava, farmers' options were

limited to either selling the cassava tubers to other farmers or traders who process and trade; or processing the tubers themselves by employing either family or hired labour. Whatever they decided to do, cassava was not allowed to remain unprocessed for long to avoid it being attacked by pests or rodents or so it did not dry up or rot. Cassava can be processed into garri, tapioca or pellets (Tewe and Bokanga 2001). If cassava was to be processed into garri, the common end product, it went through the following process:

Peeling off skin ⇨ washing ⇨ grating/grinding ⇨ bagging/draining off fluid/fermentation ⇨ sieving ⇨ frying ⇨ sieving ⇨ packaging

This process also produces residues such as unacceptable/bad tubers, peels, long fibres and hard grains.

Oil palm was usually processed into palm oil (Tewe and Bokanga 2001) or sold as palm fruits. There were no standard storage arrangements for harvested oil palm nuts or bunches. The farmer only tried to keep them cool and dry and processed them as soon as possible. The processing of oil palm into palm oil was in the following progression:

Separation of nuts from bunch/husk ⇨ washing ⇨ boiling/heating ⇨ manual or mechanical application of pressure ⇨ extraction of oil ⇨ separation/removal of fibre from nuts ⇨ more extraction of oil from fibre ⇨ decantation/filtration of oil

Residues from this process include sludge, fibre, nuts, husk and kernels. Oil palm and cassava processing sometimes involved the use of machinery by farmers who could afford it. There were simple machines for extracting oil from oil palm, for cracking oil palm kernels and for grinding cassava. Only 30% of farmers surveyed in Abua possessed any of this equipment and none of the farmers surveyed in Andoni had any.

Vegetables were only harvested on the eve of or on market days or whenever a buyer was present. Vegetables not sold on time were sold at much reduced prices or the seller/farmer might risk total loss if the vegetables were not consumed in the household. In general, there was no large or small scale storage/preservation facilities available for any form of crop produced in the region. Furthermore, there was no scheme to avoid waste or to promote recycling or processing of unsold fresh foods.

Table 4.3: Common storage and preservation methods of food crops after harvest besides processing

Food Type	Storage/Preservation method	Maximum storage time	Efficacy
Yam tubers	Barns	Up to 1 year	Very efficient
Maize	Dried close to fire places	Up to 1 year while still within leaves	Efficient, though taste/palatability is affected
Fruits e.g. pineapple, banana	Baskets Kept cool/dry	Maximum 1 week depending on fruit & ripeness	Not efficient
Vegetables	Left in the dew wrapped within large leaves	2-3 days 4-5 days	Not efficient
Chillies (Peppers)	Dried in the sun	Up to a year if stored in a dry place	Very efficient

People in these localities used traditional methods of preserving their crop produce (Table 4.3) simply because they had no other options available.

4.3.2 Livestock

Livestock are a common sight in rural communities and the two research sites were no exception. Common farm animals found in farm households at both sites were chickens, ducks, sheep and goats (Table 4.4) ranging from one to fifteen per household and raised in extensive systems. Animals raised for the purpose of sales using intensive or semi intensive systems were mainly pigs. Commercial poultry production was not popular because of its high capital costs, the susceptibility to disease and labour requirements. However, some farmers expressed interest in becoming involved in this (poultry) industry in the near future. Table 4.5 shows the pattern of animal husbandry observed during the research.

Table 4.4: Domestic livestock holdings

Livestock	Range	Average number found per household	
		Abua	Andoni
Chickens *Gallus gallus domesticus* (apart from chicks)	2-15	5	4
Ducks *Cairina moschata* (apart from ducklings)	1-6	-	3
Sheep *Ovis aries* & Goats *Capra hircus*	1-10	5	3
Pigs *Sus Domestica*	-	-	2 (Oyorokoto)

Commercial large scale production was only observed in pig production. All three commercial livestock farmers in Abua reared pigs ranging from 10 to 30 mature animals. The farmers provided commercially produced palm kernel cake and crude protein fibre for the animals and also supplemented this with cassava and other crop residues, especially when processed feed could not be purchased/ obtained for any reason. A good example is highlighted in Box 4.2.

Table 4.5 Ownership and management of farm animals in both sites

Location	Abua	Andoni
No of respondents	24	25
Total no. raising animals	9	9
No. who raise animals (commercial)	3	0
No. who raise animals (subsistence)	8	9
No. providing proper housing for farm animals	3	0
No. providing commercial feed for animals	3	0
No. providing traditional/local feed for animals	8	7
No. providing veterinary care	3	0
No. using any modern facility/technology	0	0

The animals were housed in custom built concrete houses with integral feeding and drinking areas which sometimes doubled as waddling pools for pigs to sit in. If needed, veterinary attention was sourced especially for piglets but farmers aimed to keep costs as low as possible because obtaining a vet usually involved transportation costs,

consultation and treatment fees. Pig husbandry was not observed in Andoni but "Bush" pigs that roamed and scavenged for their own meals were common in the Oyorokoto fishing settlement. They were owned but generally not managed.

Box 4.2: Pig farming in Abua LGA, Farmer Z's experience

At just 34, farmer Z had been in agriculture for about 19 years. He also had the largest stock of pigs among farmers surveyed. His pigs fed mainly on commercial feeds like palm kernel cake (PKC) but due to the high cost of this he sometimes substituted PKC for crop residues of cassava and plantain from his arable land. His major

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Fig. 4.4/ 4.5 Pigs in customised building

challenge in this venture was in the continual provision of feed for his stock due to long distance/high cost of transport and feed. Because he is not an indigene of the village where his farm is located, which is very rare, land was very expensive to purchase. He got his present farmland on a lease hoping to fully purchase it with profits from his pig farm. Being a young man with little children, who were not old enough to be part of his labour force, hired labour contributed immensely to his regular expenditure especially in obtaining water from a nearby well for farm activities. This made him embark on a bore-hole water project which only progressed with available cash. Absence of a nearby veterinary doctor had led to mortality of a few piglets so he now makes more effort to get one on hand immediately there is any sign of need. His pigs are, however, doing remarkably well and at the time of survey he was expanding his farm, building more pens (Fig. 4.4/4.5). He is determined to succeed in his pig farming because of his love for farming.

Although farm animals were common in farm households, farmers who did not have large numbers did not make reference to them without prompts from the researcher, even where the animals were raised for sale. Local breeds of chickens were common in

farm households as they were more hardy and easier to manage than “agric fowls”. These scavenged for food and suitable sleeping areas (Fig 4.6) but household feed wastes were sometimes provided. Other feeds provided were garri sometimes mixed with a little palm oil. In bad weather or when birds were ill, this was mixed with ground dry red pepper, believed to aid the birds’ good health and recovery. Domesticated poultry included chicken and/or ducks which could range from 2 to 15 per household excluding chicks.

Fig. 4.6 Chicken/chicks scavenging within plantain farm in Abua

Fig. 4.7 Small Ruminants raised in extensive systems in Andoni

Sheep and goats were still raised traditionally with most households having between 1 and 10 animals. Custom built houses were not provided and in unfavourable weather or at night, animals gathered in old or unused barns, roofed open places or abandoned premises such as uncompleted and dilapidated buildings (Fig 4.7). Sometimes forage and herbs from forests or farms are provided as feed. Other sources of feed were household food wastes, and in rare cases cassava tubers and peels and other processing remnants. These feeding methods are discussed in more detail in later sections. More of the latter were provided in the unusual event of scarcity of forage. Professional medical attention was absent in these systems and farmers with concerns about their herd’s health purchased broad spectrum anti-biotic capsules from nearby drug stores which they administered through mixture with feed or water.

Meat markets for beef, chevon and mutton (cattle, goat and sheep meat) are supplied with livestock imported from other parts of the country usually the North. “Native” breeds of sheep and goat are low in number because they are usually not domesticated in large quantities and cattle are usually migratory. The poultry industry is thriving among urban large scale farmers although it struggles with disease outbreaks and unavailable inputs.

4.3.2.1 COMMON TRADITIONAL METHODS OF FEEDING LIVESTOCK

Farmers in both locations had similar methods of providing feed for their livestock (Table 4.6) especially for livestock managed at the small scale. However, these were carried out in an unstructured and inconsistent manner. Most farmers employed only one or two methods but a few employed a variety of methods as the farmer highlighted in Box 4.3.

Table 4.6: Common methods of feeding farm/domestic animals as employed by farmers either singly or together.

Method	No. of farmers	
	Abua	Andoni
Total no. raising animals	9	9
Cut and carry of fodder	5	4
Crop residues after harvest & from processing	4	4
Set food crop aside for animals after harvest	4	3
Allow livestock graze on farm after harvest	3	3
Commercial/purchased feed and agro-industrial by-products	3	0
Household food waste	0	2

<u>Cut and carry of fodder</u>

One convenient method of providing feed was to collect forage usually for small ruminants and sometimes pigs. Forage provided was usually grasses and browse plants like elephant grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum*) and alfalfa growing wild in local forests and unused/fallow fields. The cut forage was replaced two to

three times a week depending on the number of animals involved. If the source of the forage was far from the location of the animals, a single trip a week might be made and enough forage cut and stored. Because of the prevailing weather conditions in Rivers State, grasses and browse plants are usually available all year round except in extremely dry weather or due to over-grazing. In these situations (usually for only a short while) farmers fall back on the other methods to feed their livestock.

Crop residues after harvest and from processing

Crop residues collected after harvest such as damaged tubers/crops, fruits, stems and leaves were also fed to animals in some farms. A full list of crop residues and how they are utilised by farmers is given in section 4.4. Crop residues were always available, provided farming occurs and are a good source of essential nutrients for farm animals. Crop residues were fed to sheep and goats, pigs and birds. Some farmers interviewed said they sometimes modified crop residues to suit animals' tastes and preferences. For example cassava peels may be allowed to dry up to reduce acid content, or the chaff from processing of maize to pap may be dried to promote longer storage life.

Food crop set aside after harvest

When a farmer could afford to, food crops were kept for animals after the crop had been harvested and included cassava tubers, maize and over-ripe plantain and bananas. Cassava tubers were either processed into pellets, sundried to reduce their cyanic content or were cut into small pieces and soaked in water to increase palatability. The latter method (soaking) was also done when used as fish feed. This was usually done or considered in times of feed scarcity or simply when the farmer desired to improve herd nutrition or when specially reserved for specific animals within the herd like pregnant or lactating animals. Animal types considered for this were usually pigs and goats but may also include other farm animals.

Allow animals to graze on farm after harvest

Animals especially sheep and goats were sometimes allowed to graze on previously harvested lands. They may do this freely or may be tethered to control their grazing. They were allowed to graze free on fully harvested farms or tethered in partially harvested farms.

Box 4.3: Farmer Y in Abua: Practical livestock feeding methods integrating crops

Farmer Y is a mixed farmer raising both crops and livestock including fish, in close proximity. His livestock are mainly sheep and goats and a few chickens. His animals are raised extensively and he has no proper account of the actual number of animals he owns. Because of the extensive nature of his system, he had lost animals to thieves, sickness and other environmental hazards. His animals had even been physically attacked for straying onto neighbouring farms. The livestock mainly scavenge for their feed despite the abundance of livestock feed around the household. He is one of a few farmers who own arable land close to the homestead and hence close to his animals (Fig. 4.8). This allows his livestock easy access to the farmland for grazing on stubble and leaves after harvest. Occasionally, cassava peels from processing and household food preparation waste such as yam and plantain peels are left out for all animals. When he could afford the time, fodder from the farm and nearby bushes are cut and tied to sticks in the yard. Since the livestock do not have their own pens, feeding is usually hampered. His small ruminants and poultry rely solely on farm and household products. His pigs on the other hand are produced at a large scale for commercial purposes. Pens have been provided (Fig. 4.9) and feeding is mainly by bagged industrially produced livestock feed. Cassava tubers are occasionally processed for feeding pigs. His fish ponds (Fig. 4.10) are still in the development stage and he is still working out a feeding regime. Previous attempts were unsuccessful and he encountered huge losses due to poor technical support. Fish feed was purchased at the time.

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Fig. 4.8 Intercropped pineapple/plantain farm Fig. 4.9 Pig housing with plantain farm Fig. 4.10 Fish pond close to pig farm

Household food wastes

Remnants of food from farm households were sometimes given to domesticated livestock. These also included food which had gone bad or, in rare cases, food prepared in excess. Inedible portions from food preparation like peelings from plantain, yam and cassava and discarded grains after selection of grains like rice and beans also fall into this category. Stock which benefitted from this practice were usually chickens and ducks but sometimes sheep and goats, if they were near to the household at the time.

Commercial feeds and agro-industrial by products

Farmers whose stock could not be sustained by the above methods alone, usually large scale producers, also provided commercially packaged feeds for their livestock. This practice was only observed in large scale pig production. The main feed purchased for pigs was palm kernel cake and sometimes crude protein. Agro-industrial by-products were sometimes purchased from factories within and around the State. Most popular was wheat bran purchased from breweries. This could be fed to the animals on its own or could be supplemented with local/traditional feeds.

In general, livestock production in Abua and Andoni had not being modernized. Manual and very labour-intensive routines of feeding, watering and other farm operations were still carried out even in large scale production. At both sites, there were no laws either protecting livestock or prohibiting their free movement within the community. Domesticated livestock which were not housed and fed intensively or semi-intensively were usually prone to environmental forces e.g. bad weather and also social attack. For instance, animals that strayed unto arable farms in search of food were sometimes physically attacked and in extreme cases injured or even killed by the farm owner. In other cases, if caught by the land owner, the animals were held by them or taken to the village police station where they were bailed by their owners and compensation paid for any damage caused by the erring animal.

4.3.2.2 PRESERVATION OF MEAT AFTER SLAUGHTER

Fresh meat was sold on the day of slaughter, or small animals like poultry and sometimes goats/sheep were sold as live animals to the buyer. In local markets, there was neither mechanism for selling frozen or refrigerated meat nor for preserving or technically processing meat not sold on the day of slaughter. Even meat dried or roasted cannot be stored without refrigeration for more than two to seven days depending on level of dryness.

4.3.3 Fish Production

Fishing was a major activity in the research areas particularly in coastal Andoni. Fishing settlements like the Oyorokoto fishing settlement in Andoni visited by the researcher, are common in coastal parts of the State and located close to the open sea. Fishermen in both sites utilised locally made nets (*ojuguru* and *Njin*) hooks and traps (*Adigheel*, *Egum* and *Edek*, *alot*) (Figs. 4.11/4.12) and most went fishing in dug out fishing canoes or boats which could be manually steered with paddles, poles and sails or mechanically powered by out-board engines. In the Oyorokoto fishing settlement of Andoni LGA, only 2 (8%) fishermen surveyed possessed out-board engines for powering their boats. Because these traditional fishing boats were not equipped with fish preservation systems, fishermen had to return to shore after a night of fishing so fish and shrimps/prawns could be received fresh. Other sea foods such as periwinkle or Ntutut (*Tympanotus fuscus)*, cocle or urion (*Anadara senilis*), oyster or efie (*Gryphaea gasa*) and whelk or mgbut (*Thais coronate*) were usually gathered by women and children in muddy mangroves and swamps.

Aquaculture was also present even in the riverine communities. Three Andoni fishermen and four Abua farmers surveyed also possessed fish ponds in experimental stages with more farmers showing interest. Aquaculture is still at a basic level and most farmers involved were still under self-training, learning by experience with little technical support. Fish feed in aquaculture included commercially packaged feeds and local feeds like soaked cassava pellets. There was only limited interaction between fishing systems and crop or animal production.

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Fig. 4.11 Making fishing traps in Abua

Fig. 4.12 Fishing nets (Njin) in Andoni

Fish processing in these sites was very important because there were no storage mechanisms in place for the local fishermen and Oyorokoto in Andoni where most fishing activity of the region was carried out, was without electricity. Fishermen therefore sold their catch immediately after arriving ashore. Any fish left was gutted, cleaned and dried over open smoke and sold as dry fish. Fishing settlements like Oyorokoto were equipped with specialised drying huts built by farm households to accommodate large scale drying of fish and crayfish/shrimps/prawns on “altars”. Fish could be dried to various degrees, the drier the fish, the longer it could be preserved lasting between 3 days to 3 weeks without refrigeration. Periwinkles, crabs, oysters and other sea foods could be preserved for longer in appropriate conditions or under simulated marine environment. Periwinkles were often shelled by women and children or could be sold unprocessed. These processing activities give rise to waste or by-products such as fish gut, scales, blood and shells.

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Figure 4.13/4.14: Sorting and grading of fish and shrimps on sea shore by women in Oyorokoto, Andoni and showing fishing boats on shore

Fish processing stages

Sorting (usually on the beach [Figs. 4.13/4.14]) ⇨ Preliminary washing with sea water ⇨sale of fresh fish/ gutting of fish for drying (Fig. 4.14) ⇨sun drying and curing with salt ⇨smoking over fire

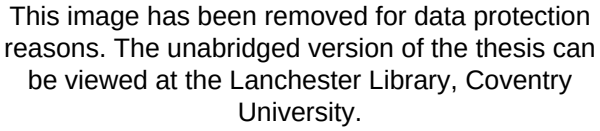

Fig 4.15 processing (de-scaling/gutting) of fish by women and children in Oyorokoto, Andoni

4.4 Agricultural wastes

Agricultural wastes accumulated in these parts of the State were mainly crop residues, food processing wastes and animal and fish wastes. These are classified as organic wastes and, where properly managed, could improve sustainable food production within the system (Allison *et al.* 1998). A comprehensive list of these agricultural wastes and how they were generally handled by farmers is provided in Table 4.7.

Most of the waste materials listed in the Table 4.7 were found at both research sites and farmers often dealt with these products in similar fashions. Most farmers handled these wastes using more than one method. The handling of agricultural wastes by site is discussed below.

Table 4.7: Major agricultural wastes produced in research sites and common methods of handling them

Waste	Examples	Handling
Crop Residues	Reject cassava tubers	Resold as low grade cassava Animal/fish feed
	Weeds and other Leaves (cassava, yam, maize and plantain)	Animal feed/Manure, mulch or compost Thrown away or burnt
	Oil palm husk and fronds	Used for building native huts Thrown away or burnt/Husks used for fire
	Plantain trunk	Left to rot in farm
	Peels from cassava, yam, plantains, bananas	Animal feed
	Reject bananas, plantains, ruined fruits (oranges, pineapple, pawpaw)	Thrown away
Animal waste	Dung (poultry, swine, sheep/goat)	Manure/Fish feed/Thrown away
	Reject feeds	Thrown away
	Feathers from birds (especially after processing)	Thrown away
Fish and sea food waste	Scales and gut	Thrown away
	Waste/reject after sorting/grading	
	Periwinkle shells	Sold/used for building and other construction work
Processing waste	Cassava peels and unwanted fibre and grains	Animal feed Thrown away
	Maize cob and chaff	Chaff used for animal feed/Thrown away
	Ground nut shells	Thrown away
	Oil palm nuts (kernels & Shell), fibre and sludge	Kernels sold/ eaten as snack kernels' shell sold/used for road construction. Also used as energy source i.e. fire fibre and sludge thrown away
	Bone and blood from livestock Animal offal	Blood thrown away/buried Bone/offal sold in meat markets
Household waste	Food remnants Plantain and yam peels after food preparation	Animal feed Thrown away

4.4.1 Common Methods of Handling Agricultural Wastes in Abua

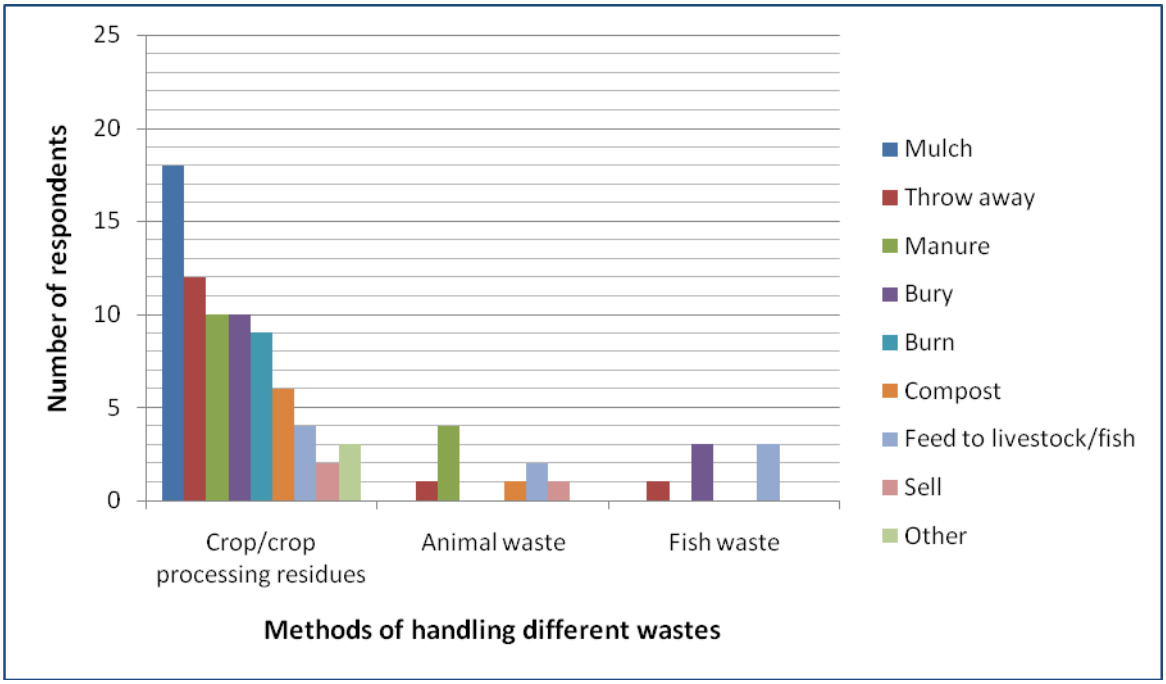

Figure 4.16: Farmers handling of Agricultural wastes in Abua

The above chart shows that mulching was the most popular way of dealing with on-farm crop residues among respondents in Abua. Crop residues utilised as mulch/manure were usually made up of weeds, other leaves and residues from previous harvests/farm clearance. Farmers interviewed indicated they used crop residues as mulch more as a way of dealing with the residues than for its fertility benefits. Mulching was mainly for major crops like cassava, maize and yam (to protect mounds from erosion) but was also applied on other crops where more mulching material is available. In other cases, the residues were burnt on farm, thrown away in fields, in fallow farms, in bins or nearby dump sites. In some cases, residues were kept for composting or just left in parts of the farm not in use to dry up and integrate with the soil over time. Only four farmers, less than half the number of recorded crop/livestock farmers in Abua, admitted to feeding crop residues to their small ruminants and pigs.

Figure 4.16 also shows that the integration of animal and fish waste within the farming system was not widely practiced in the region. Only a few farmers (less than 20%), positively employed animal waste as manure or as livestock/fish feed. They were mostly thrown away in abandoned fields or dumps. Blood from livestock slaughter was not usually gathered and bones were sometimes sold. Where they are not purchased, bones are often used in making soups in farm households or thrown away. Fish gut if not used as fish feed in aquaculture, is thrown away or buried. Animal and fish wastes were usually regarded as just that, wastes and a nuisance and the first option was usually to dispose of them without regard to any form of reuse. Less popular methods of handling agricultural wastes were to sell or simply donate them to other farmers where they might be utilised as fish feed in ponds.

4.4.1 Common Methods of Handling Agricultural Wastes in Andoni

In comparison, there was less activity in the handling of agricultural wastes among respondents in Andoni (Fig 4.17) than in Abua. This could be because there were fewer crop farmers here and hence fewer residues. These crop farmers, however, used the residues mostly as manure in similar ways to farmers in Abua. Crop residues were similar to those found in Abua but were present in smaller quantities and were handled in similar ways except that no farmer in Andoni acknowledged feeding crop residues to livestock.

Fish wastes were usually thrown away into rivers, while animal blood wastes were buried. Dung, feathers and other wastes were thrown away in plantations and in bins or dump sites. Fish waste formed the bulk of agricultural waste produced in Andoni given that it is a coastal region, and its handling was the major distinguishing factor between both research sites. All farmers/fishermen in Andoni admitted to throwing away the guts, scales and other unwanted parts of the fish into the river. The researcher was told that any other method that allowed these wastes close to households could attract snakes.

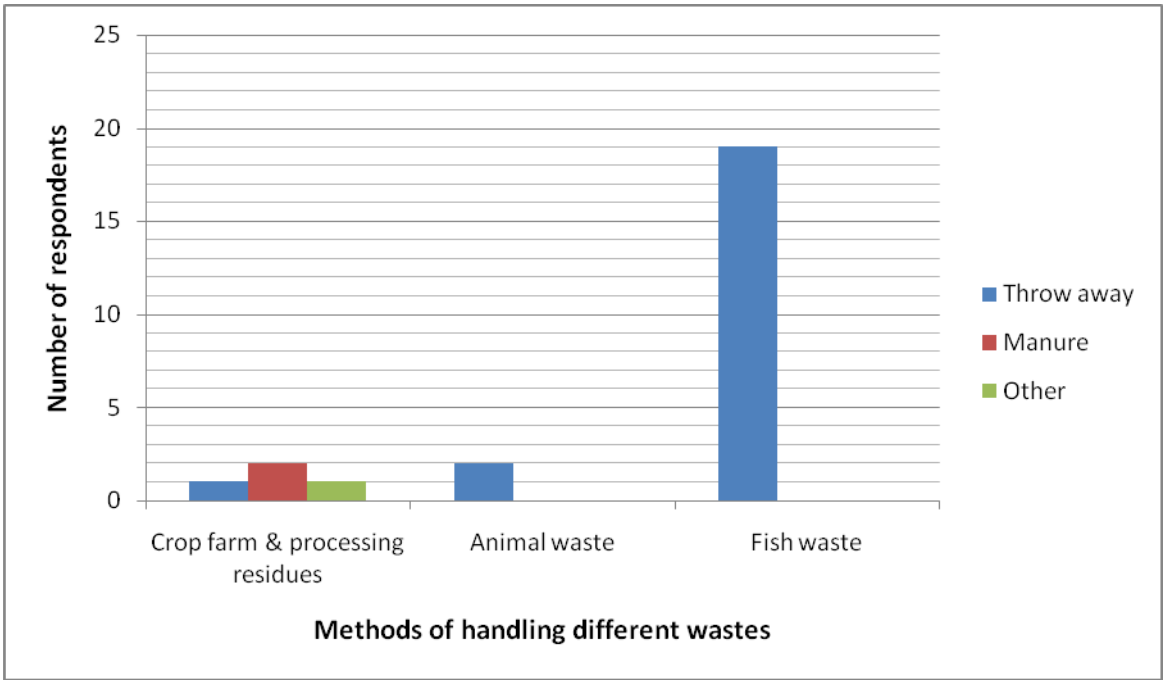

Figure 4.17: Farmer's handling of agricultural wastes in Andoni

4.5 Crop Livestock Integration in research sites

The researcher's observations in both sites highlighted the little interaction that occurred between crops and livestock. Although there was some form of livestock in most households in the locations visited, the figures in Tables 4.5 and 4.8 represent animals declared in questionnaires and/or during interviews.

Table 4.8: Farmers involved in more than one form of agriculture

Location	Abua	Andoni
No. of respondents	24	25
Farmers having both crops & livestock	8	9
Farmers involved in crops, livestock & fishery	4	6

Forms of interaction present were the feeding of crop residues (as discussed in section 4.4) and also feeding of processing wastes mostly from cassava. Crop livestock integration in crop livestock systems occurred more where farmers raised animals close to their

farms than when far apart. Feeding of processing wastes was also encouraged by the proximity of processing sites (usually homesteads) to livestock. Farmers involved in fishing handled them separately from other enterprises without interaction. But some farmers with ponds experimented with fish guts and animal dung as fish feed and also some amount of cassava pellets.

Although all farmers generated crop residues, animal wastes and other materials that could promote sustainability within the system in one form or another, there was generally low recycling of nutrients at both sites as little effort was made to utilise and integrate these in the farms. Generally, nobody took the time to gather, store and transport such items from source to area of need.

4.5.1 Constraints to feeding agricultural wastes to livestock

It was observed that agricultural wastes within the farming systems in the research sites were not efficiently recycled or utilised as livestock feed. This lack of integration was due to one or a combination of any of the following factors based on farmers' comments/reasons given and on the researcher's own observations.

- DISTANCE, TRANSPORTATION AND LABOUR COSTS

As noted above, integration was encouraged by closeness of enterprises. Some farms were located within the community but most large farms were further away. Farmers commuted to their farms on bicycles and trucks were only hired to convey harvested produce from large farms. It was not considered profitable to hire trucks for conveying crop residues to livestock even though they could be more nutritious than the grasses fed to them and could replace commercial feed. Long distance of farm is usually coupled with the problem of the bulky nature of crop residues and high transportation costs. Because most villages and local communities do not have their own transportation systems, any vehicle hiring is arranged from motor parks outside the community making it more expensive for farmers. Also where family labour is not employed, the farmer would have

to pay for the residues to be manually hauled into trucks, for stacking and also for the residues to be fed daily to animals.

- BULKY NATURE OF CROP RESIDUES

Crop residues are bulky especially when still fresh. This made it even more difficult to transport them from site to animals especially considering how few animals they could feed. Animals close to farms may be sent to the farms but this is not feasible when farmlands are far from animals. Hay and silage making, which could aid in solving this problem, is not known or practiced in the region.

- USE OF RESIDUES AS FOOD FOR HUMANS

Crop residues in farms including those from maize and other damaged crops, and also edible animal offal are increasingly being used as food for human consumption especially with increasing poverty levels. Some processing residues such as hard garri grains separated after sieving were also in this category. In such cases the residues are consumed in farm households or sold in markets rather than fed to livestock. Livestock only get to consume leaves and other portions which are inedible by humans. This factor also affects the feed option of setting aside some harvested crops for animals. The farmer may sometimes have to consider profits that could have been made from sales of such crops.

- CULTURAL BELIEFS

Fish gut is usually thrown away especially in Andoni where farmers believed this could attract snakes into households if kept for other uses. The researcher was told that any other method like burying in plantations or farms to improve soil fertility could invite snakes which they claimed fed on such material. Weeds were thrown away in unused fields or burnt to avoid them sprouting up again if used as manure or mulch.

- LACK OF FARMER KNOWLEDGE

During interviews, the researcher observed that farmers knew little of the methods and benefits of recycling agricultural wastes in farms for livestock such as the use of household and farm wastes in making compost for farm use.

4.6 Other Factors Affecting Food Production

Farmers were asked in questionnaires, to mention the main challenges that limited their food production capabilities and negatively influenced their farming practices. Although the study locations had issues peculiar to their localities and physical environment, there were some general inhibiting factors limiting food production common to both. These include lack of finance, provision of commercial feed for livestock/fish, lack of modern farming implements and pest attack on crops. Figure 4.18 represents the problems identified by the farmers at the two research sites. Note that most farmers identified more than one problem.

As Figure 4.18 shows, finance was the issue most commonly raised by respondents in Abua with about 80% of farmers citing this. The area was also prone to pests and disease attack given the heavy rains and humid conditions. Seasonal flooding is also particular to this area during the annual rainy season and affected farms incur loss and damage to crops and farms without compensation.

Although finance was also an issue in Andoni, farmers here seemed to be more concerned by the lack of modern implements in farming and especially in artisanal fishing. Fishermen interviewed in Oyorokoto fishing settlement said fishing was made more difficult by the local equipment they had which, apart from being very labour intensive, also limited the amount of catch they should get per fishing trip in comparison to modern equipment. They also complained of the presence of international fishing trawlers in their fishing sites, which according to them encroached within the territorial boundaries marked out by the government. Livestock and aquaculture feed was also a major concern.

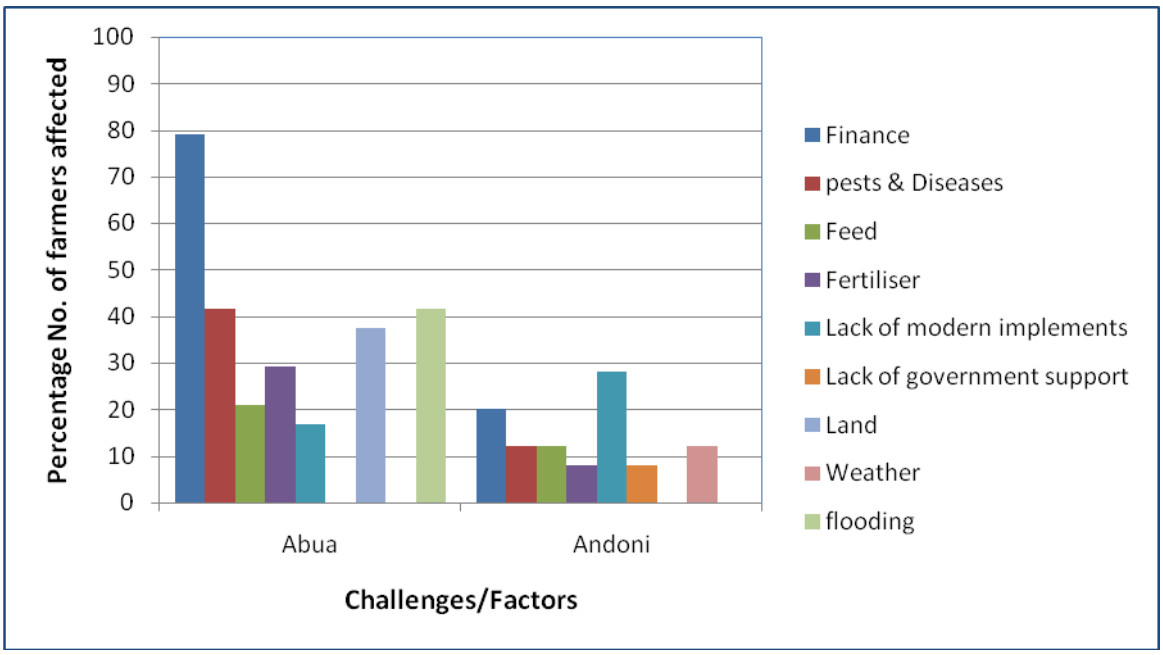

Fig. 4.18: Challenges identified by farmers in Abua & Andoni

4.6.1 Constraints to Provision of Commercial Livestock/Fish Feed

Large scale livestock farmers at both sites all depended on commercial feed for the bulk of their animals' feed requirements. The provision of commercial feed is discussed here as issues with local feed have been discussed in section 4.5.1. In addition to the factors outlined earlier, preventing the use of local feed resources, these farmers of pigs, small ruminants and fish (aquaculture) encountered constraints in providing bulk commercial feed. The major difficulty was in capital for purchasing and transporting feed compounded by the absence of feed mills in the State and unavailable depots for feed resources within rural communities.

4.6.2 Finance

Most farmers seemed to be hindered by finance for expansion and continuity especially following an unfavourable harvest season or market day. Nineteen farmers in Abua and five in Andoni mentioned finance as a major hindrance to their food production

capabilities. This figure represents about 50% of the farmers involved in the research. At the time of the survey, farmers' main sources of income did not vary much from location to location and from farmer to farmer. The majority of finance came from the sales of farm proceeds and from loans from the Federal Government through special programmes and local co-operatives (Figure 4.19).

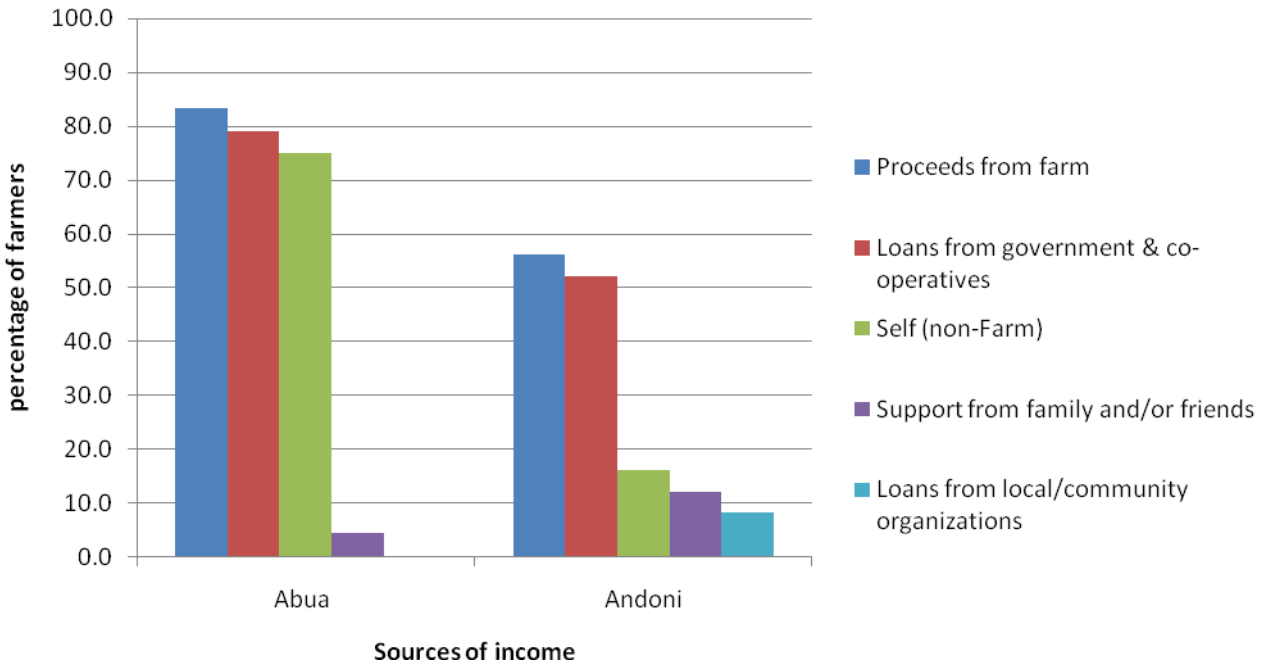

Figure 4.19: Sources of farm income according to farmers in Andoni & Abua

4.6.3 Technological Challenges

Machinery for farming was absent in all locations visited by the researcher. Only four farmers in Abua possessed machinery for either cassava grinding or palm kernel pressing. None of the farmers surveyed in Andoni owned this equipment. Livestock and fish processing and storage involved no mechanization and was conducted entirely by hand or with simple household tools. Oyorokoto, the fishing settlement visited in Andoni, was also without electricity. Farmers engaging in aquaculture at both sites had been given very little training.

Processing methods and technologies available to local farmers in Nigeria include sun drying, smoking, roasting, boiling, chopping/chipping/slicing, shredding, grinding, grating and fermenting in earthen pots or alternative containers (Tewe and Bokanga 2001). These traditional and ancient methods were in use but only effective in short term food crop and meat preservation.

4.6.4 Physical and Environmental Factors

In this research nine farmers in Abua had challenges with access to and cost of land for farming. Acquisition of farmland did not seem to be a severe problem in Andoni probably because there were fewer farmers in this region than in the former. Generally, farmland was becoming more expensive to purchase by farmers willing to expand production, and soil productivity was declining.

Fertilisation was not common in the sites visited. During a group session, farmers highlighted some challenges associated with fertilisers including the high cost especially for farmers with extensive farmland, and their poor availability and distribution. This is aggravated by the negative or unpleasant results farmers sometimes experience, such as spoilage or partial destruction of fertilised crop, due to improper application techniques. Other farm chemicals such as herbicides and pesticides also had low popularity but had been tried at least once by seven respondents in Abua and one in Andoni.

Farmers indicated that sometimes bad weather contributed to low crop, livestock and fish production. For instance, excessive rain usually led to seasonal water-logging and flooding of farms in Abua and in rare cases to flooding of rivers in Andoni. High winds and torrential rainfall reduces the number of trips the fishing boats make thus reducing fish catch for the season and pushing prices up.

Furthermore, because the long rainy season in the region promotes an increase in the incidence and quantity of weeds, farmers were constantly dealing with the hiring of labour to clear and dispose of them and this was becoming more expensive. In addition,

ten Famers in Abua and three in Andoni had suffered damage to crops and animals due to pest and disease infestation and straying domestic animals.

4.6.6 Transportation and Marketing of Goods

Farmers used simple and often laborious methods to transport goods to market especially in areas with bad or inaccessible roads. Some farmers interviewed argued they did not usually receive good prices for their farm produce commensurate with the amount of labour put into the production process. Sometimes, agricultural produce was only sold to avoid total loss through spoilage. Generally, there was no organised market system or association to set or regulate standards of quality, grading and pricing of local farm products.

4.6.7 Lack of Support

Farmers were unanimous in their agreement that more financial and technical support was needed from the State's government authority. Extension agents were present in both localities visited but the extension agents were required to cover several communities/farmers at a time and to give information on all aspects of farming including crop, livestock, fishing and aquaculture. Vets were generally not resident in villages and rural communities.

4.7 Chapter Summary

Food production in the study areas is practiced by people of varying ages with more male farm heads than women. A wide variety of crops are grown even in coastal areas and farmers also raise livestock including poultry, pigs and small ruminants. Fishing is done in both locations. Some farmers are involved in more than one form of agriculture and all systems produce agricultural wastes which are often not integrated into the food production circle for various reasons. However food production is also impaired by similar

sets of factors at each research location, particularly constraints in finance, land, livestock and fish feed and technological knowledge.

Chapter 5

ANALYSIS AND DISCUSSION

5.1 Introduction

Small-holder farmers are the bedrock of agriculture and food production in Rivers State and are located in rural communities. The following sections discuss the data provided by these small-holder farmers as part of this study. The influence of farmers' socio-economic status on food production is analysed in the first section followed by a discussion of the food production trend in Rivers State based on the results of the study. This leads to an analysis of the systems of food production and their driving forces. Crop livestock integration (CLI) is then discussed with reference to space, time, ownership and management and the methods employed by local farmers in the research sites. Finally, methods employed by farmers for livestock feed provision are evaluated.

5.2 Socio-economic factors and Food production

5.2.1 Age

Farmers in both research locations had an average age of 36 and 38. This is similar to the average age range of 35 reported by Allison-Oguru, Berepubo and Kalio (2002). More farmers were found in this age range for a number of reasons as highlighted below.

- The native customs and traditions of the Rivers State people encourage older men to hand over farmland to their heirs.
- Most people below this age range in the community were either attending school or had gone to the cities for non-farm jobs or were simply not trusted to handle the running of the farm.
- Farmers at this age had achieved the financial, mental and physical strength needed for the job and often had their own families who act as the farm's labour force.

Older farmers above 60 who still engaged in farming activities tended to need more labour hands especially if their own children had farms. However, they could get support from family members or employ labour while they take on a supervisory and advisory role. As Okike *et al*. (2004) observed, age of heads of farm households influences farm activities impacting evidently on the quantity of food produced. Their study concluded that food production declined with increasing age of household/farm head. Quantity of food produced is, however, not severely affected where elderly farmers employ help, although labour costs are increased.

5.2.2 Gender

Women were generally involved in farming activities contributing to sowing, weeding and harvesting of grains and vegetables while the men cultivated tubers and tree crops. Processing of cassava into garri and the shelling of ground nuts is almost exclusively left to women as is common throughout the Niger Delta region, in southern Nigeria (NBS 2006). These activities are carried out as a matter of tradition, not convenience. The involvement and activities of women in major farm operations contribute to high yields and improve the general household food production potential. Statistics from the National Bureau of Statistics (2006) indicate that men have more access (75%) to agricultural land. This could be attributed to existing village land tenure systems which only allow men to inherit land.

5.2.3 Educational Level

Literacy of farmers was important in the knowledge and adoption of technologies and innovations. Practices such as fertiliser application were hampered because farmers could not read labels and instructions. This supports previous surveys in Nigeria which indicated that over 50% of its agricultural practitioners were uneducated (NBS 2006). These same studies also found a direct relationship between poverty and educational level with the poorest households having uneducated heads.

5.3 The State of Food Production in Rivers State

Rivers State food production is clearly below the needs of the local population as indicated by the observed rate of food importation into the state. Foods such as yam, fruits and vegetables, although produced in the state, are being brought in daily from states throughout Nigeria as well as livestock and fish. Farmers interviewed also suggested that Rivers State still does not produce enough food crops and livestock for its population and has not made optimal use of its land and water resources. Farmers were, however, divided on whether fish production was high enough for the Rivers people, acknowledging that fish from Rivers State is also being exported to neighbouring states. The exportation of fish is not because there is a surplus but rather because fishermen and traders seek better prices by selling outside the state. Foods crops are usually imported because they may be cheaper than local produce but the latter is usually preferred for taste. There is no rearing of cattle by local farmers because northern nomads bring them through Rivers State. The trading of food items between Rivers and other states of the federation has become widespread but should not discourage the improvement of the State's agricultural sector.

The low exposure to the developed world had also left farmers with a myopic vision of farming. Farmers have been sceptical about taking on new projects involving trials or planting of introduced crops for fear of crop failure and loss on their part. Most farmers would rather not take the risk. The adoption of new farming methods, different from traditional ways, is also slow when there is no known record of positive results within the state and no incentives for change. In most cases the acceptance of the introduced variety or farming method was not so much dependent on its improved yield or taste as the consumers' preference for the end quality of the processed good.

Food production in Rivers State has been influenced by the following factors.

- The trend of food imports has reduced pressure on the food production systems of Rivers State to produce more and the cost of food items is hence always being increased.

- The low production is also due to inadequate technologies used in farming. The use of manual labour and hand tools reduces the efficiency of farmers and fishermen as more time is spent in producing relatively little.

- Veterinary clinics are absent in the rural areas. This has led to the loss of meat and animal products due to mortality caused by disease. Cost of treatment of animals also discourages livestock farmers from seeking the assistance of vets.

- Much of the food produced is also lost through spoilage due to inadequate storage facilities of food crops and fish and livestock products. Items with short shelf lives such as tomatoes, pineapples and other fruits, plantain and vegetables such as pumpkin, sea foods such as fresh fish are often damaged when they are not sold in good time. The lack of electricity in most rural areas exacerbates the problem.

- The food processing technologies in place for most food items make the process slow and arduous. This reduces the efficiency of the system and discourages expansion.

- The raising of livestock in extensive systems not only slows food production but also reduces it. Livestock are sometimes lost when they are foraging unsupervised. Also animals that are attacked and maimed are of lesser economic value.

Efforts to address these factors in conjunction with better use of farm resources currently going to waste, would help to improve food production in Rivers State and indeed the Niger Delta. These farm resources are found in all agricultural production systems in the

state. From the land clearing to harvesting and processing stages, farm resources could be stable sources of livestock feed especially since farming is done all year round due to the prevailing ecological climate. Resources were also available in all sectors of agriculture including arable and tree crops, livestock and fishery and could be integrated in more effective and diverse ways such as the integration of sheep and goats in tree crop plantations.

5.4 Moving from Specialized to Mixed Farming

Specialized farming (farming only either crops or livestock) is common. Most farmers in the study sites concentrated more on growing crops and invested their farm income and labour this way. Relatively few animals were kept around the household for wealth diversification and for traditional purposes. Specialized farming is as a result of low population pressure on existing land (McIntire, Bourzat and Pingali 1992) but the pressure brought about by increasing land costs and costs of meat products can be positively geared towards mixed farming. In Abua, livestock production was observed for about 45% of farmers, some producing only on a small scale in domestic households while in Andoni, only small scale livestock production was observed involving 36% of farmers.

Crop production is preferred for a number of reasons including the following:-

- Crop production requires less capital investment to start up than large scale livestock production. Animals can still be raised cheaply in a domestic setting.

- Crops feed a larger number of people than livestock per unit area, as also observed by Schiere, Ibrahim and Van Keulen (2002).

- Livestock usually demand more farmer attention than crops in the areas of feeding, protection and sanitation and this most farmers claimed they couldn't always do as Scheire, Ibrahim and Van Keulen (2002) also observed. This is also compounded with farmers raising their livestock far from arable farms where they spend most of their time.

- Farmers tend to direct their income towards one activity where they perceive quicker profit is to be made.

- Crop farming is preferred as returns could be received in a relatively short period as livestock, beside chickens, have longer growth and maturation period.

In addition, most small scale livestock farmers did not put much effort into the venture because animals such as small ruminants are hardy and can produce high quality protein with scavenged food. Secondly, these animals are not usually considered as part of the agriculture business because of their small numbers and their system of husbandry. This extensive system of animal husbandry was as a result of many factors including the following

- Inconvenience experienced in feed provision. Sometimes farmers did not want to take the time to gather local feed for livestock especially if it meant going away from the close surroundings of the homestead. Constraints were experienced more in Oyorokoto, Andoni, where crop farms and forests were far from home.

- Expense involved in construction of livestock housing because money was usually limited. Coralling in fields has not being recognized as a system of raising livestock.

Although the number of mixed farmers was low there is potential for more adoption of CLI by local farmers if crop farmers are encouraged to pay more attention to livestock enterprises. This move could consequently improve food production.

However, the results from the research villages suggest several possible limitations to the adoption of mixed agriculture:-

- <u>Labour Requirements</u>

  Because agriculture in the research sites was very labour intensive and employed crude implements, farmers were wary of increasing work load through introduction of new ventures. On the other hand, appropriate integration could effectively use labour to accomplish better yields in crop and livestock production.

- Investment Capital

  Farmers often took on ventures they could sponsor themselves given that most of their farm income came from their personal savings. This restricted the type and scale of farming practiced as livestock projects require relatively higher capital especially for large scale production. Finance was required for labour, farm inputs and machinery as indicated by 50% of total farmers involved in this research.

- Available Land

Land was an important challenge especially to farmers in Abua, with almost 40% of farmers experiencing difficulty in accessing land. This corresponds with previous research that only 16% of the rural population in Rivers State outrightly own their land (NBS 2006). Land fertility and suitability for particular agricultural activities such as the planting of root and tuber crops like yam and cassava, was also important. Cost of land also determines the establishment of new projects and expansion of existing ones. Oil palm, for example, is grown throughout the Niger Delta and can be successfully integrated with crop production, but is capital intensive as a good plantation requires considerable land which is expensive for local farmers.

5.5 A Comparison of Existing Crop-Livestock Integration Techniques in Abua and Andoni

- Firstly, both sites had similar number of farmers having both crops and livestock although an organised livestock system was only observed in Abua with pig farming.

- Integration in both areas was hindered by the scattered geographical distribution of crop, livestock and fishing activities.

- Waste from fish and other sea foods were the most important residues in Andoni because of the prevalence of fishing activities but these were not utilised as

sustainable farm resources. The practice of throwing away fish offal is habitual and is exacerbated by the fact that farmers are oblivious of its benefits.

- Crop and processing residues were the most common farm resources found in Abua since people here farmed more crops. These were often left on the farms because of transportation difficulties and mostly used as mulching material. They were sometimes burnt or thrown aside.

- Composting of crop residues and household wastes for use as manure/compost was rare in both sites mainly because farmers lacked the technical and educational knowledge of its uses and processes.

- Transportation was more difficult in Andoni than in Abua/Odual LGA given that the former is a coastal region with fewer roads and vehicles. Abua on the other hand, had more vehicles in the transport system but some transporters were hesitant to travel to farm locations which often had dirt roads or to carry food stuff or materials in their vehicles which could make them dirty.

- Domestic ruminant livestock in Abua were commonly fed by the cut and carry method of providing fodder while in Andoni, they scavenged more and received household wastes or food.

- Pig farming was only observed in Abua where farmers supplemented commercial feed with residues such as cassava peels and tubers. Pig husbandry was more successful here because trade is, especially because of the proximity of the location to both the hinterland and riverine areas of the state

- Seasonal flooding in Abua suggest that farmers may need to diversify their agricultural businesses to reduce loss and risk. Also integrated farming would need to be carefully planned so as not to expose the animals to harsh environmental elements.

- The use of animal power or draught animals was absent at both research sites. This is because cattle rearing was not practiced since northern nomads usually brought these.

5.6 Constraints to Crop-Livestock Integration in Rivers State

The results of this study indicate that crop, livestock and fishery resources are available for effective crop livestock integration in Rivers State. The reported reduction in fallow periods and soil fertility (Otto 2000), coupled with increasing costs of commercial feeds and fertilisers, all indicate that food producers in Rivers State will have to make the most use of any natural farm resources available to them. Crop livestock integration in Rivers State would however, be more effective if all features of the system are considered and site specific recommendations made. The dimensions of CLI, according to Sumberg (2003), which must thus be evaluated, are space, time, ownership and management.

5.6.1 Space

A major problem hindering CLI in Rivers State is the spatial location of agricultural enterprises. The spatial layout of local communities is designed such that large crop farms are located at the outskirts of the town far from the homestead while livestock are raised closer to home for safety and security reasons, and ease of management. This automatically separates both enterprises and hampers integration. These distant arable farms provide the bulk of crop residues reported in the study and for this reason the majority are left to go to waste. According to Sumberg (2003), bio-physical relationships and exchanges between crop and livestock systems increase with closeness of farms and are maximised when they are both raised on the same farmland.

The distance between farms and markets has also not encouraged the trading of these resources in farms and markets. For instance, materials from maize including cob, grain, sheaths, tassels and stubble commonly found in farms and markets are often a nuisance as they are left to decay or carried away by waste disposal trucks. Exchange of crop residues and manure is more easily achieved when issues of transportation do not have to be dealt with.

Some smaller farms of between ½ and 2ha are found within communities as observed in Abua. These farms could furnish the feed needs of domestic and small scale livestock but

crops were often threatened by wandering animals. This is because suitable housing and steady feed were not provided for such livestock, as was found in both research sites. Sometimes feed crops were cultivated in these farms especially by mixed farmers to provide a readily available high quality feed resource for livestock. These dual purpose crops also satisfy immediate needs of households when they cannot visit their distant arable farms. Cassava is already commonly fed to livestock but maize also has potential as a dual purpose crop (Lenne and Thomas 2005). Maize, like cassava is readily available, affordable and often produced in large quantities. Others are yam and leafy vegetables. However, these efforts are usually not optimised as most crops are sold as food and livestock are kept in extensive systems and not tended to.

5.5.2 Time

Timing of farm activities to synchronise interactions between crop and livestock would effectively utilise resources. This is closely related to the understanding of seasonality in agricultural production. Most farmers, for example, did not have animals to make use of crop and processing residues after harvest and did not make arrangements to sell to farmers who needed them. Farmers tend to leave such issues to chance and the result is a clumping of available resources and the consequent problem of disposal.

Presently very few farmers deliberately let livestock onto fallow farms or at the end of the farming season. Corralling livestock on farmland (especially those close to the homestead) during the dry season or before tillage is not common though this has been successful in other parts of Nigeria (Hoffmann 2002). This practice could improve the soil fertility problem, which about 40% of surveyed farmers complained of and could be easily employed since most animals sleep outside anyway. The feeding of household food waste is only common for domestic animals raised within the homestead. However, this alone cannot provide all nutritional needs of the animal but can act as a supplement to other feeding methods.

5.5.3 Ownership

Where farmlands are not owned by the farmer, decision making might take longer and may not favour CLI. In Abua, for instance, farmlands were still held on lease, hindering the extent to which farm improvements took place and the choice of agricultural activity. Women, who made up about 30% of the agricultural workforce, may require permission before some activities are carried out in farms belonging to spouses. Although ownership guarantees a steady supply of resources and avoids issues of costs and transportation, it is not a pre-requisite for successful integration as functional arrangements could be made with owners of necessary resources, such as the manure-crop residue contracts observed in the middle belt (Omolehin, Steinbach and Hoffmann 2003).

5.5.4 Management

The sole management of crop, livestock or fishery projects whether separately or within the same farm, encouraged better interaction between the systems as seen with farmer Y in Box 4.3. When management is under the same person, household or group, farm activities could be synchronised so as to avoid waste within the whole system. It also eliminated challenges of waste management, supply of farm resources and transportation difficulties (Sumberg 2003) which occurred with farmers who did not manage resources they wished to use. As noted in Chapter 4, the bulk of farm resources were under-utilised over 50% of the time and mostly thrown away, although they were abundant and could form major inputs in the system.

Management of farming activities or agricultural businesses in Rivers State is poor given that farmers did not keep records, account books nor did they draw up any farm management plan. Most farm managers were also unaware of crop livestock integration techniques and other practices that could improve food production in their farms. Also techniques for aquaculture, feed preservation and formulation were not known and livestock and fish keepers ended up purchasing commercial feeds all the time.

Another problem of farm management in Rivers State was the extensive nature in which livestock were raised. Besides the three pig farmers in Abua, who provided feed and housing for their animals, all other livestock keepers in the research sites did not give adequate attention to their animals. Consequently, output was negatively affected. Scavenging animals were usually unhealthy and were prone to destroying crops in farmlands (further reducing food production). In Andoni, where goats are arrested for trespassing and destroying farmlands, fines and compensation are constantly being paid. One farmer interviewed admitted to paying compensation on almost a monthly basis since his animals seemed to always be getting into trouble. However, these setbacks have not deterred farmers from raising their animals this way. This is mostly because of the belief that raising livestock is expensive and laborious. In addition, most small-holder farmers do not have a business orientation especially in the small scale production of goats, sheep and poultry.

Manual labour coupled with the lack of machinery and other farm equipment already makes farming burdensome. All activities carried out by the larger scale pig farmers in Abua were done manually. Existing high labour demands in farming systems of Rivers State, has made farmers hesitant to integrate their farms for fear of increased manual labour. This apprehension is further compounded by reportedly increasing labour costs while farmer finances are already stretched. Also, manual labour greatly reduces the area of land that could be put into food production (Kidane, Maetz and Dardel, 2006).

5.6 Chapter Summary

Food production in Rivers State appears to be below population demand given the observed rate of import. The apparent reasons for this low production need to be addressed and farm resources put to better use. Crop farming is more popular than livestock but integration could be encouraged by simple changes to local farming systems. CLI in both research sites was low but agricultural wastes were produced and their usage limited by similar factors. Constraints to food production in Rivers State

include the spatial separation of farm activities, the poor timing of activities, ownership issues and ineffective management practices.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

Local farmers in Abua and Andoni represent farming systems found throughout the state. These farmers form the backbone of agriculture within the state and if improvement in food production is to be made, it must be through the involvement of these small-holder farmers. This chapter summarizes all aspects of the research work. It has been divided into sub headings to highlight the major conclusions and suggested recommendations for the Rivers State agricultural industry as it moves towards sustainable food production, through best practice crop livestock integration methods.

6.2 Summary of Research Findings

Rivers State has the potential to be a food secure state with its ample natural resources and available labour. The proper management of these resources is what remains. Food crops are farmed in preference to livestock and artisanal fishing is common and more popular than aquaculture. However, crop livestock integration is often left to chance and less than 40% of farmers surveyed actively practised it. Available resources produced within the farming systems of Rivers State include farm remnants, processing residues, animal dung and market waste. Farmers fail to exchange these between farming systems for various reasons including inaccessibility, bulkiness of the product, ignorance on the part of the farmer coupled with poor extension services and importantly, the physical/geographical separation of crop and livestock production systems.

Studies have shown that CLI improves yield, produces more food (crop and meat), diversifies income source of the farmer and thus generates more finance for the household (McIntire, Bourzat and Pingali 1991, Schiere, Ibrahim and Van Keulen 2005). With the introduction of the sustainable development agency, agriculture in Rivers State has been tasked to produce food through economically and socially acceptable means while maintaining environmental quality. The adoption of crop livestock integration

techniques could be an important strategy for achieving this as they utilise internally generated inputs giving local farmers more control and better use of farm income.

6.3 Recommendations for Improving Crop Livestock Interactions

Rivers State food production could be considerably increased by improving CLI through better manipulation of the dimensions of space, time, ownership and management.

6.3.1 Space

Optimal use of available farm space could be achieved in a number of ways. The integration of livestock in tree crops has been successful in developing countries (Devendra and Li Pun 1993, FAO 1983, ILRI 1997). Rivers State fits under a suitable profile recommended by FAO (1983) for successful livestock-tree crops integration. The dry season is mild and short lasting between 5 to 13 weeks and animals will have roughage all through. Also, there is adequate moisture through rainfall to cater for the needs of both trees and forage.

There have been studies to promote simple technologies for conserving and transforming bulky fodder and crop residues into more manageable forms that could be easily transported and also made readily available in dry months of scarcity. These simple methods are also practical for farmers in sub Saharan Africa and involve little cost requirement (Lenne and Thomas 2005). They include box-baling and bag silage which are methods for improving the storage capabilities of plants such as maize stover, fodder legumes, and a wide range of tropical feed materials including grass. These techniques have not been introduced to Rivers State because of the abundance of grass and browse for the most part of the year. They would however be useful in reducing bulky feed stuff.

The farmer could also effectively utilise residential space by tethering/keeping his animals within a confined area so as to gather dung which can be transported later to fields for fertilisation. This system practiced in Kano, Zamfara and Benue States of Nigeria (Agbulu

and Idu 2008, FAO 2001, Hoffmann 2002) and by some farmers in Rivers State, could be used more effectively to provide a steady supply of manure. It is also cost effective since the area can be swept by household members and the manure can be transported in bags or basket as the farmer commutes to the farm.

6.3.2 Time

Timing of farm activities and planting dates could also be better organized so as to help the farmer accomplish more with little time. This could include the mixed cropping, intercropping or double cropping of dual purpose food/feed crops such as cassava and maize, plantains and bananas. Furthermore, if production is slightly raised it could cater for more animals without much impact on the market for human food. This may be a great avenue for providing high quality livestock feed. Also diversification of agricultural enterprise can reduce the losses encountered during the seasonal flooding of crop farmland in Abua. By venturing into other activities such as semi-intensive animal production, snail keeping and aquaculture, risks are minimized and the farmer will be better cushioned in the event of a flood.

Also farmers could work with professionals to synchronise farming activities so that while residues are being produced, they could immediately be utilised in other areas. The use of labour saving farm machinery such as tractors, animal pulling ploughs, cassava grinding machines, transportation vehicles and modern fishing tools would not only save time but would also reduce the drudgery associated with farming.

6.3.3 Ownership

Although outright ownership of a venture or farm business is more profitable (Omolehin, Steinbach and Hoffmann 2003), the sharing of resources between specialized farmers of either crop or livestock through the creation of markets and contracts could also be good substitutes for mixed or integrated farming. Also farmers need to farm on larger pieces of land even though it is done collectively. This will promote more support from

stakeholders and will ease the use of modern technology in farming such as mechanisation. Processing equipment such as those for milling palm oil and also storage facilities such as a cold room for meat and meat products, can be jointly owned/hired by farmers working with their existing co-operatives. The use of such facilities will greatly improve food access, quality and stability. In addition, the absence of a breeder house and hatchery for chicks is a main factor discouraging large scale poultry production among rural farmers in Rivers State. The establishment of one will make chicks readily available for production.

The transportation challenges noted in transporting farm generated products (harvested food, residues) and commercial livestock feed could be alleviated by the use of motorised three wheel vehicles. These are cheaper alternatives to trucks and may need to be sponsored by the government or public and private investors in areas where farmers cannot afford them. These tricycles are already common in the urban areas, nicknamed "keke Napep" after the Federal Government's project that sponsored them. However, they are used as taxis in cities as a cheap means of transport instead of being utilised as agricultural vehicles in rural areas, for which they are best suited. Ownership of these tricycles could assist local farmers to improve production and bring crop and livestock activities closer, especially where wagons are fitted.

6.3.4 Management

Concise management efforts could save energy while reducing health and physical hazard, labour and discomfort. Deficiencies in farm management have adversely affected food production particularly, meat production. Local breeds of farm animals could do better under improved management and chicks and piglets would have better chances of survival. The exploitation of feed resources such as crop residues, animal wastes and processing residues as mentioned in Table 4.7 would also encourage local farmers to provide these readily available feed options for their livestock and fish. Extension agents could also use more effective means to teach basic management tips to farmers such as prevention of diseases and provision of shelter. Post-harvest losses for the market could

also be minimised by the improvements of storage technologies and facilities (Kidane, Maetz and Dardel, 2006).

Proper farm management techniques should focus on the entire farm system including soil, plants/animals and the entire agricultural environment (FAO 2001). In this regard, farm management must consider how a change in one aspect of the farm could influence another and how these can be made to work together. In pig husbandry for instance, if the farmer takes the time to collect household waste and crop residues from the farm as food, preparation should also be made on how to store these appropriately so the pigs may receive them in good condition. The farmer should also make preparation ahead of time for removing manure from the pens, its handling and optimum application times. The farmer may also further consider how the growth of his pig farm will influence his immediate family and the community. This all round management planning can avoid losses and utilise labour effectively.

Proper management entailing good hygiene, feeding, housing and early detection of anomalies can also eliminate disease outbreak thereby minimising the need for veterinarians. On the other hand, some indigenous knowledge and technology can be creatively modified to produce solutions that benefit not just the local communities but the wider world. For instance, the existing technologies in food preservation could be re-evaluated to make them more effective. An example is the sun drying of chillies (peppers) which could be processed more hygienically using same methods and packaged in bags for the market and for storage. This will not only improve market value of the product, but will also reduce losses.

6.4 General Recommendations for Improving Agricultural Production

6.4.1 Land access and use

Land is the single indispensable factor in agricultural production and its importance is highlighted in farmers' responses. Increasing urbanisation and reduced access to land, coupled with increasing populations to feed, indicate that land needs to be used more

efficiently to fully synergise soil, crops and trees, fish and animal interactions, to sustainably produce food (Rasul and Thapa 2003, Timon 1993). Farmers who indicated they needed more land for expansion could adapt their system to mixed crop-livestock farming to make optimal use of their available land. Land use could be further optimised by the planting of tree crops of fruits, cash crops and timber to boost household income and nutrition while ensuring environmental/ecological sustainability (Rasul and Thapa 2003).

Agricultural land should be given due priority and made slightly cheaper so farmers can obtain farms closer home as most obtain distant farms because they are cheaper besides the fact that they are vast.

6.4.2 Controlling pests and disease

This is essential if farmers, crops and livestock are to benefit from the advantages of an integrated system of farm management. Also it was an important challenge to food production in the research sites, negatively affecting over 40% and 10% of farmers in Abua and Andoni respectively. Farmers could be encouraged to employ natural and low cost techniques of manipulating and reducing the effect of pests and disease on crops and livestock. For crops, these include planting resistant varieties, phyto-sanitation including selection of clean disease-free seeds for planting and manipulating planting and harvesting dates. Extension agents could assist in teaching farmers to identify, isolate and destroy infected plants and/or plant parts. Usual practices of intercropping, multiple cropping and crop rotation could also be exploited in conjunction with experts or extension workers, to reduce the incidence of attack (Lenne and Thomas 2005). Pesticides, fungicides and herbicides and inorganic fertilisers should be applied with caution and only in recommended doses as farmers with access to these sometimes failed to follow set instructions. Livestock diseases could be controlled by prevention, good and clean housing, isolation of sick animals and removal of infected faeces, vaccination and fortification of feed.

6.4.3 Better Use of Co-operatives

The research observed that co-operatives were formed only to receive loans from the government. An urgent need for the development of the marketing systems of agricultural products is needed in Rivers State to encourage farmers to pay more attention to their livestock. Small scale farmers and co-operatives could work together to improve marketing channels and set standards on the pricing of meat and crop products. co-operatives can also easily establish relationships and form manure-crop residue contracts and a market for processing residues and other local and farm generated feed resources. Commercial livestock feed, fertilisers and other farm inputs can also be purchased collectively to reduce costs and transportation difficulties. Co-operatives could also be used as avenues of dispensing information on profitable agricultural practices.

6.4.4 Improved Government Support

One of the reasons for poverty among rural farmers is because they were always returning their profit into the business and thus were left without adequate profits for household improvement. Farmers agreed financial loans from the Federal Governments' Food Security Programme were usually helpful but often insufficient for bigger projects. A study of the actual needs of farmers in the region before grants are set is important because previous loans from the Federal Government were approved at the national level based on what farmers in a different region needed which was not always commensurate with agricultural activities in Rivers State.

Farmers in Rivers State need a re-orientation of agricultural practices. Extension services which had been slow in adapting to changes in global agricultural systems need to be reviewed to help rural farmers achieve sustainability and not just food production. Extension services also have to be improved to meet the needs of farmers moving from specialized to mixed farming. The Department of Agriculture in the State's University also needs to be reviewed, lecturers brought up to date with world agriculture and facilities updated. Rather than just the dissemination of general facts and advice, extension teaching methods should also focus on the real life issues faced by these local farmers

such as flooding, livestock feed provision and preservation and processing of food products (Wallace 1997). The particular needs of women should also be considered and approaches designed to meet those needs since women are such an important part of agriculture in Rivers State.

Agricultural extension agents can also facilitate the acceptance of new innovations by farmers if they approach the local people with understanding of their current situations and with respect for their cultural beliefs. They should also be clear about the perceived future benefits of the innovation and have good research about the consequences of introducing such change. As most accepted innovation is abandoned after a while if the villagers do not like the results (Ojoko 2000). Local knowledge should however, not be discarded as they may be useful in encouraging acceptance of a new development that is based on indigenous technology (FAO 2001).

The State Government's contributions to agriculture had been negligible according to the recipient farmers. Agricultural projects and policies could be more effective if a proper background study at the farm level is first carried out to obtain accurate and appropriate data (Amir and Akhtar 1993). This is important as Rivers State is a peculiar state with lots of different communities having different traditions and customs. Peculiarities in physical and ecological structures across the state should be taken into account as what might obtain in the hinterlands may be ineffective in the coastal areas.

The Rivers State Sustainable Development Programme should be patterned to work closely with farmers and communities in the provision of veterinary care, advice on resource use and methods of integration including methods of feed preparation.

6.5 Areas for further research

Crop residues and animal and fish wastes produced in Rivers State have great potential to fulfil dietary needs of domestic and commercial livestock. More research is needed to ascertain the nutrient content of the available resources and how they could be

combined or formulated to meet all nutritional needs of different animal species. This could profit intensive pig production which is currently reliant on concentrate feed.

An investigation of nutrient content of these forages and residues and the suitable methods of improvements needs to be carried out so farmers can benefit more. Methods of enhancing the physical and chemical features of locally produced agricultural wastes should also be studied to improve palatability, longevity and nutritional content.

Secondly, mixed farming systems such as crop-livestock, livestock-fishery, crop-fishery and crop-livestock-fishery need to be assessed for feasibility and for the different components of residues that could be integrated in each.

The production of cattle on the rangelands in Rivers State needs to be properly evaluated and integrated into the state's agricultural programme. It could be a better source of meat production utilising the vast forage available and encourage the use of draft animal power.

Chapter 7

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Appendix 1

Rivers State Population Figures

Source National Bureau of Statistics (2006b)

Appendix 2

Questionnaire

Department of Sustainable Agriculture, Faculty of Business, Environment and Society
Coventry University, UK

Research- The Potential for Improved food Production in Rivers State, Nigeria through Effective Crop-Livestock Integration

Questionnaire for farm businesses in Rivers State

Thank you for agreeing to take part in this study. Please make sure you understand each question and answer appropriately.

About you
1. Name of Participant.....
2. Sex Male☐ Female☐
3. Age at last Birthday.....

About your farm
4. What do you Farm? Please name all
Crops.....
Tree plantations.....
Livestock.....
Fishing.....
Aquaculture.....
Other.....

4b. Location of farm(s).....
.....

5. Approximate size of farm
Crops/ trees ..... hectares
Livestock ..... hectares
Aquaculture ..... m^2
Other .....

6. If you have livestock, or fish in your pond how do you feed them?
a. Commercially processed feed ☐
What kind, composition.....

b. Cut and carry of fodder ☐
Where do you get them from for example your farm, forest, neighbouring farms etc.....
.....

c. Allow livestock to graze in farm after harvest ☐

d. Allow livestock to graze in farm to control weeds ☐
Do you tether them or allow the livestock to graze wildly.....
How do you protect the food crops.....

e. Grow certain crops specifically for livestock or fish ☐
what crops.....
Do these crops have other uses? For example as food for man..... if yes what other uses
.....

f. Other means of feeding livestock.....

7. Do you always find feed for your livestock at all times of the year?
.....

8. If there is any scarcity at any time, what do you do to provide food for your animals?
.....
.....

9. What are the main challenges you encounter in providing food for your livestock or fish fingerlings?.....
.....

10. How do you counter these challenges?
....
.....

11. What are the main challenges you encounter in your crop farm that limit food crop production?
.....
.....

12. How do you counter these challenges?
....
.....

13. Do you process any of your farm produce or alter them in any way before you send them to the market?
.....
.....

14. If yes, what kind
Cassava to garri ☐
Oil palm to palm oil ☐
Livestock slaughter and butcher ☐
Fish cleaning and drying ☐
Other.....
.....

15. Apart from traditional farming methods, do you make use of any modern technologies in your farming or processing example use of machinery, fertilisers, pesticides and herbicides or other farm chemicals?
.....
If yes,
what.....

16. What kind of waste products is generated from your farm?
Crop residues after harvest ☐ from what crops.....
Weeds after weeding of farm ☐
Animal dung ☐ what animals.....
Residues after processing ☐ .....
Fish waste ☐ .....
Other.....

17. What do you usually do with the waste?
a. Burn ☐ where.....
b. Use as mulch ☐ dry or in fresh state..... .....
c. Make into compost ☐
d. Bury ☐
e. Throw away ☐
where.....
f. Sell ☐ to whom.....
g. Feed to livestock ☐ what do you feed to what
livestock.....
h. Use as manure ☐ in what state, dry, mixed with other form of manure etc.....
.....
i. Other.....

18. Have you tried any form of crop-livestock integration in the past? .....
What did you do? .....
Did it work out positively? .....

19. How would you rate your current methods of handling farm wastes?
Good ☐ Fair ☐ Poor ☐

20. Why did you choose the above rating? .....
.....

21. Will you be willing to amend your farm practices to make better use of your farm resources?
.....

About your experiences
22. What other challenges do you encounter in your farming businesses that limit your production capacity?
.....

23. As a farmer, do you believe Rivers State has the capability to produce enough food for its people without the need to import food from other states i.e. food that can be grown here?
....

24. In your opinion, do you believe Rivers State is producing enough food to feed its people and the surrounding states? ....

25. Why do you say so?
.....
.....

26. How many years have you, as an individual, been farming? .....

27. Please give me two major reasons why you decided to go into farming
.....
.....

28. How do you support your farm financially?
Self.....
Family.....
Proceeds from farm.....
Government.....
Loans from bank and other cooperative societies.....
Other.....

29. What area(s) of your farm (if any) do you intend to expand within the next two years?
.....
.....

30. Is farming
Your occupation.....
A hobby.....
A family business.....
Other.....

Thank you for taking the time to complete this questionnaire. If you are chosen for further interviews you will be contacted shortly.

Appendix 3

PARTICIPANT INFORMATION SHEET

1. Study title

The Potential for Improved Food Production in Rivers State, Nigeria through Effective Crop-Livestock Integration

2. Invitation Paragraph

This is an invitation for you to participate in a research study. Please take time to read through the following paragraphs which tells you more about the study and your expected involvement. You can ask me for more information or further explanation. Take time to decide whether or not you wish to take part.

3. **What is the purpose of the study**

The purpose of the study is to assess the potential for achieving more stable food production in Rivers State, Nigeria through farmers' adoption of best practice crop-livestock interaction methods. The study is a Masters Degree research project.

4. **Why have I been Chosen**

You have been chosen to take part in this study because you are involved in local food production in Rivers State. A total of 50 farmers will take part.

5. Do I have to take part

You do not have to take part if you don't want to. However if you do decide to participate, you will be required to give your full consent by signing a consent form. You can also decide to withdraw from the study at anytime.

6. What will happen to me if I take part?

Your will be required to complete a questionnaire with my assistance. If you are chosen for the next stage, you will be interviewed for about 45 minutes and your farm may be visited to make observations while you go about your routine farming activities. Subsequent meetings with you, at your farm, may be organized at a suitable and convenient time. The study is of an observational nature and does not involve experiments and poses no risks to you or your farms. Your participation in the study will span two (2) months.

Expenses and Payments

You will not need to pay to take part in the research and you will not be paid for taking part. The study will not cause any change or increase in your farm expenditure. A souvenir will however be presented to you at the end of the study.

7. What do I have to do

You will be required to make yourself available for interviews and to complete questionnaires. You may also have to make your farm available for observations.

8. Will my taking part in the study be kept confidential?

Your personal details will not be disclosed or included in any part of the literature. Your name and personal details on forms or documents will only be for identification purposes only and will only be used by the researcher.

9. What will happen to the results of the research study

The results will be analysed and will form part of my Masters thesis. Your identification will not be disclosed in the finished work.

10. Who is organising the research

I am a student of Coventry University in the United Kingdom. The research is being supervised by the University.

11. Who has reviewed the study

The Research Degree Committee and the Research Ethics Committee will review the study.

12. Contact details

For more information you can contact me on

akeg@coventry.ac.uk

Telephone number removed for data protection reasons.

Coventry University
+44 (0) 24 7688 7688

Thank you for taking the time to read through this sheet and for considering taking part in this study. You will be given a copy of the information sheet and a signed consent form to keep.

Information Sheet version 2.0
Date : December 2007

Site Number:
Study Number:
Participant Identification Number for this trial:

CONSENT FORM

Title of Project: The Potential for Improved Food Production in Rivers State, Nigeria through Effective Crop-Livestock Integration.
Name of Researcher: Grace O Ake

Please initial box

1. I confirm that I have read and understand the information sheet dated June 2007 (version 2.0) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected ☐

3. I agree to take part in the above study. ☐
4. Please tick the box if you are willing to be contacted for further interview ☐

_____	_____	_____
Name of Participant	Date	Signature
_____	_____	_____
Name of Person taking consent (if different from researcher)	Date	Signature
_____	_____	_____
Researcher	Date	Signature